Proceedings of the Licensing Review Committee Concerning Deafness

FINAL REPORT

September 24, 1998

Prepared for the Committee by

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1.0 INTRODUCTION

1.1 Background

The Superintendent of Motor Vehicles, at the time of a Human Rights mediation concerning a deaf driver, agreed to chair a Licensing Review Committee that would review the functional aspects associated with safe commercial vehicle operation and the relationship to hearing. This is the report of the Licensing Review Committee Concerning Deafness.

For clarification purposes, the terms "severe to profoundly deaf" is defined as an individual with a hearing loss of 70 dB and greater, whereas "moderately deaf" is defined as an individual with a hearing loss of between 40 and 69 dB, averaged at 500, 1000, and 2000 hertz in the better ear. The term "aided" describes the hearing loss with use of a hearing aid.

1.2 Mandate of Committee

The Licensing Review Committee on Deafness was established to investigate the role of hearing as related to the functions associated with the safe operation of a commercial vehicle.

1.3 Committee Members[1]

The Committee is comprised of representatives from various British Columbian agencies. In alphabetical order, with titles and sponsoring agency, the Committee members are:

- Claire B. Eraut, Chair
  Deputy Superintendent of Motor Vehicles
  Office of the Superintendent of Motor Vehicles

- Roger J. Carver, MEd
  Deaf Community Representative

- Ed Domovitch, MD
  Medical Consultant
  Office of the Superintendent of Motor Vehicles

- P. Ann Guinchard, MES
  Senior Standards Coordinator
  Office of the Superintendent of Motor Vehicles

- Frederick K. Kozak, MD, FRCSC
  Otolaryngologist

[1] Although the Committee members' names are listed, opinions expressed in this report may not reflect each member's personal opinion.

- Vicki Farrally, Chair
  Superintendent of Motor Vehicles (until September 9, 1997)

- Peter Threlfall, Observer
  BC Human Rights Commission
  Mediated the Complaint Settlement that established this Committee

This document reports the proceedings of the Licensing Review Committee Concerning Deafness and reflects the matters considered by the Committee. As well, the various views of the Committee are reflected in the body of this report.

It was noted that Dr. Frederick K. Kozak fully participated in the activities of the Licensing Review Committee Concerning Deafness up to and including reviewing and commenting on the penultimate draft of this report. Dr. Kozak did not provide his final input and comments on this report.

2.0 ISSUES

2.1 Recommended Hearing Guidelines[2]

The Superintendent of Motor Vehicles, by statute, has the final responsibility for determining an individual's fitness to drive. In this context, fitness refers to medical condition. Commercial drivers tend to work long, irregular hours, can carry passengers for hire and drive greater distances and in more adverse conditions, compared to drivers of private vehicles. The risk of mortality and severe injuries is higher for commercial vehicle accidents. For these reasons and others, medical requirements for commercial drivers are more stringent than for drivers of private, passenger vehicles. Appendix A outlines the British Columbia Licence Classes, relevant vehicles permitted and the associated hearing guidelines.

2.2 Issues for Consideration

During the first Committee meeting, September 29, 1997, a list of pertinent issues was compiled. Each issue with the relevant discussion is listed below.

1. <u>What are the functional requirements of driving commercial vehicles that require hearing?</u>

   Because of their size and weight, commercial vehicles exacerbate severity when involved in an accident. In addition, statistics show that 78% of fatalities involving a medium to heavy truck and another vehicle were the occupants of the other vehicle (U.S. National Highway Traffic Safety Administration, 1995). Thus because of the potential for severe consequences, driver requirements are more

[2] *Guide for Physicians in Determining Fitness to Drive a Motor Vehicle, 7 th Edition*, The British Columbia Medical Association, Vancouver, BC, 1997.

stringent for commercial vehicle licences than for private vehicle licences.

Robinson et al (1997)[3] studied the role of hearing for safe commercial vehicle operation and evaluated the Federal Highway Administration hearing requirements. Information gathered from surveys of commercial vehicle drivers resulted in a list of tasks that were deemed to need hearing to perform safely (See Appendix B for the list of tasks). Additionally, The European Directive Model for Driver Licensing is outlined in Appendix R.

2. Who are the other stakeholders?

Direct:

- Insurance Corporation of British Columbia
- Deaf Community and Deaf Drivers
- All Highway Users and the General Public
- Ministry of Transportation and Highways
- Employer/Industry with an Interest in Commercial Vehicles and Drivers
- Other vehicle insurers, e.g. Insurance Association of Canada

Indirect:

- Transport Canada
- Ministry of Health Ambulance Service
- BC Transit
- Other North American Jurisdictions Pertaining to Commercial Vehicles and Drivers
- Unions

3. How does the Office of the Superintendent balance a Deaf Individual's Wish to Drive Commercial Vehicles?

This issue is better addressed after dealing with the evidence, outside agency

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[3] Robinson, G.S., Casali, J.G. and Lee, S.E., Role of Driver Hearing in Commercial Motor Vehicle Operation: An Evaluation of the FHWA Hearing Requirement, Final Report, Virginia Polytechnic Institute and State University, September 1, 1997.

reports and examining the functional requirements of safe driving where hearing is required (see Appendices B, J, K, L and section 4.3).

4. Is the focus provincial (BC only), national or international?

Through the Canadian Council of Motor Transport Administrators, British Columbia has signed a Memorandum of Understanding (MOU) with other Canadian jurisdictions to follow the medical guidelines outlined in the National Safety Code. This MOU guarantees that British Columbia drivers meet the medical and functional abilities of the other jurisdictions, thus allowing commercial drivers to transport goods freely across provincial borders (see Appendix D).

In 1982, the members of the Commercial Vehicle Safety Alliance (Canada, United States and Mexico) signed a two-part agreement. First, commercial drivers could cross international borders if they met the medical and skill requirements outlined in the agreement. Second, the vehicles had to meet prescribed operational and safety requirements.

Starting in 1998, Canadian truckers will not be required to carry an ICC (Interstate Commerce Certificate) medical card. Where medical fitness is part of Canada's licensing process, the US will recognise Canadian commercial drivers' licences except for those of insulin dependent diabetic drivers and deaf drivers. Therefore, international standards must be considered.

5. What published studies are there regarding an increased number of accidents for deaf drivers?

There is little research assessing the safety differences, if any, between hearing and deaf drivers. The deaf population is small. These drivers have traditionally been limited or restricted from commercial driving. Regarding statistical information, police do not routinely record the pre-existing medical conditions of drivers involved in accidents. The Committee did not locate studies that demonstrated a clear cause and effect relationship between deafness and increased accidents, although the authors did conclude that there was a correlation between deafness and accident risk. The available studies are included in Appendix C. The Committee concluded that it may be inappropriate to rely on this evidence.

6. What is the trigger for individual assessments by OSMV?

The Office of the Superintendent of Motor Vehicles (OSMV) is not obligated to render individual assessments. In general, individual assessments are not practical, financially feasible, or a safe option for all drivers. With respect to profoundly deaf commercial drivers, it would be impractical because of the risk to the driver, examiner and others, particularly with respect to uncontrolled railway crossings. Furthermore, no test is available that has been proven to be valid and reliable in respect to the determination of safety in profoundly deaf commercial drivers. However, an individual assessment to confirm the ability to communicate, in respect to Class 2 and 4 licences, may be considered for drivers with hearing loss marginally in excess of the standard, a demonstrated ability to compensate for deafness in a commercial context, and who meet other requirements as set out in the Superintendent of Motor Vehicles position on pages 19.

7. How does OSMV develop individual assessments?

In cases where warranted and safe, the development of an assessment protocol with an Occupational Therapist or other specialist may be considered to fit the case requirement.

8. Who pays for assessment?

The Office of the Superintendent of Motor Vehicles is re-assessing this policy.

9. How do compensatory mechanisms/techniques for hearing loss get assessed/approved?

The Office of the Superintendent of Motor Vehicles and the Deaf Community have researched the availability of driving aids, such as siren detectors, there are several examples of available technology, except for those designed to detect train whistles. Appendix V is a copy of the only evaluation report submitted to the Committee, regarding the effectiveness of audio alarm detection devices. There is ongoing research and product reliability development concerning technical assistance, but at this time, none proven to compensate for the hearing limitations connected with safe commercial vehicle driving. No jurisdiction has agreed to offer commercial licences restricted to the use of such devices.

There are a few practical and technological compensatory options available to the deaf driver, e.g., soap solutions to detect air leaks, mechanical failure warning lights and siren/horn audio detectors

A. Dangerous Goods Restriction

As to assessing the effectiveness of compensatory mechanisms/techniques for profoundly deaf drivers regarding Class 1 and 3 licences, and dangerous goods restrictions, a formal assessment would be impractical, as there are no available assessment tools. Additionally, the restriction is based on the potential

consequences of an accident with dangerous goods rather than functional driving abilities.

British Columbia has a legislated requirement for drivers transporting dangerous goods and passengers to "stop, look and listen" at uncontrolled railway crossings. There is no practical way to assess whether it is safe for a deaf commercial driver to cross an uncontrolled railway crossing that has a limited view due to: geography, weather conditions or man-made structures.

B. Emergency Vehicles

It would be irresponsible for a licensing agency to place a driver and a driver examiner in a situation where either could be injured. This is the primary concern the assessment of a deaf individual with operating an emergency vehicle, ie., multi-tasking duties assessment at high speeds (see Appendices J and K).

10. Are there better measures of hearing ability than the audiogram?

To evaluate a driver's hearing abilities, most licensing agencies primarily rely on an audiogram, while others used a "forced whisper test". Several Committee members question whether the results of an audiogram represent the relationship between hearing loss and safe driving. A Committee member suggested that it was conceivable that individuals with hearing loss greater than the current guidelines may have functional abilities that compensate. However, no jurisdiction considers any technological measure or factor other than the audiogram for evaluating the licensing of a deaf driver.

The Committee was not able to obtain the information on the scientific justification for the hearing loss level deemed to be acceptable in the National Safety Code. Nevertheless, both the Canadian Medical Association and the British Columbia Medical Association support this standard. The British Columbia Otolaryngologist Society is reviewing its position on the decibel guidelines recommended in the NSC. British Columbia has signed a Memorandum of Understanding (MOU) to respect the medical guidelines outlined in the National Safety Code.

According to the Deaf Community, there is a difference in compensatory abilities between people who were born deaf, have early onset deafness and those who are recently deaf. The Committee has not found or reviewed any research to support this contention. Regardless of the age a driver became deaf: individuals differ in recognition of limitations, willingness to compensate and ability to compensate.

11. Development of model for standards.

Without comparisons of accident and violation rates between the deaf and hearing driving populations, establishing revised standards is problematic. The

logical approach would be to examine the tasks associated with each commercial licence class (see Appendices B, J, K, and L) and then determine the tasks that require hearing.

2.3 Dangerous goods

British Columbia drivers may obtain Class 1 and 3 licences if the uncorrected hearing loss is less than 55 decibels, averaged at 500, 1000 and 2000 hertz in the better ear (see Appendix A). The National Safety Code guidelines recommend no more than 40 dB corrected hearing loss in the better ear, averaged at 500, 1000 and 2000 hertz (included in Appendix A).

In general, Canadian jurisdictions (until recently, Ontario, Quebec and New Brunswick each had several drivers who were not restricted within the specific provincial borders) base restricting deaf drivers from transporting dangerous goods (see Appendix D) on considerations such as:

- drivers should be able to hear warning sounds (e.g., sirens, vehicle horns, and railroad grade crossing alarms);
- drivers should be able to hear mechanical noises associated with malfunctions or faulty equipment;
- drivers should be able to effectively communicate with emergency personnel and other drivers in emergency situations (e.g., by TTY with the carrier[4]);
- hearing is crucial in order to detect malfunctioning equipment when hazardous or petroleum products are involved (i.e., tank shutdown orders, malfunctioning pumping equipment). Tank Truck companies are subject to stiff penalties for spills into the environment;
- the possibility that carriers would be subject to more public liability and recovery actions, and
- the risk imposed by uncontrolled railway crossings and the severe consequences of an accident by a commercial vehicle.

In addition to the concerns listed above, the BC Motor Vehicle Act, section 185(4)(f) requires drivers transporting dangerous goods to stop, look and listen at uncontrolled railway crossings for approaching trains (see Appendix E). Members of the Committee inquired whether listen meant with the ears only or if the definition would include visual display audio-detection devices. No such technology, aside from hearing aids, is currently available, except at a research level, but it estimated that the earliest train whistle detection devices may be available is two years. In any case, use of devices other than hearing aids does not satisfy the legislative requirement to "listen".

[4] Carrier refers to a trucking company.

2.4 Passengers for Compensation

Driving passengers for compensation dictates a variety of communication tasks, ranging from the ordinary (requests for directions on a bus) to emergency situations (instructions to a ambulance operator from a hospital during a medical crisis). It is essential that passenger carrying vehicle operators have the ability to detect and respond to the verbal, medical and emergency requirements of the passenger (s), co-workers, agency dispatcher and emergency personnel.

When a crisis occurs, reaction time can mean the difference between life and death for the passengers under the care of the driver and for co-workers (see Appendices J, K, and L).

Although a profoundly deaf driver may be able to drive a Class 2 or 4 vehicle, the fundamental objective of a commercial driver is to safely transport passengers to the prescribed destination. In the context of Class 2 and 4 licences there are several issues to be considered:

1. Can the driver adequately assess the needs of his or her passenger (s) in routine and emergency situations?

2. Can the driver quickly detect and respond to sirens, horns, train whistles and the actions of other vehicles?

3. Can the driver quickly respond to the needs of his or her partner and co-workers, including dispatchers?

4. Can the emergency vehicle driver deal effectively with emergency situations, which require communication with passengers, bystanders, other drivers and emergency personnel?

5. Can a driver detect visual cues as quickly as audio cues?

In addition to the issues raised regarding passengers for compensation, an ambulance driver must be able to communicate with a partner, dispatch, in some cases a hospital emergency department, family members of the patient, witnesses to the medical crisis, and most importantly, fully assess and monitor the passenger's medical status. In respect to fire fighters, the driver has to be cognisant of the situation, be alert to distress from his or her fellow fighters, possibly people within a burning structure, and may have to initiate and maintain crowd control.

Inter-jurisdictional Agreements

A. AGREEMENTS

It is important to point out that medical guidelines regarding commercial licences are part of agreements with other jurisdictions; thus, modifications could have a

potential negative impact for all BC drivers.

- The Canadian provincial jurisdictions have signed a Memo of Understanding with the CCMTA (Canadian Council of Motor Transport Administrators), that they would honour the medical recommendations established by the National Safety Code (NSC).

- The American and Canadian Federal Departments of Transportation have developed a Memo of Understanding that will equalize medical standards between the two nations. This medical reciprocity will eliminate the need for Canadian drivers to obtain an U.S. medical examiner's certificate (ICC card). In addition, the U.S. Commercial Driver's License will be recognized as proof of medical fitness to drive.

- The American Federal Highway Administration has determined that the Canadian National Safety Code medical guidelines are equivalent to the American medical fitness regulations, except for insulin dependent diabetics and deaf drivers. Thus, Canadian commercial vehicle operators will be allowed to drive in the United States except for insulin dependent diabetics and deaf drivers who do not meet the American medical requirements.

B. HONOURING INTER-JURISDICTIONAL LICENSING AGREEMENTS

Discussions with other Canadian jurisdictions revealed that in order to maintain inter-jurisdictional agreements to honour licensing standards some modifications are made to National Safety Code medical guidelines, within that specific jurisdiction, e.g., Ontario allows a few, pre-NSC agreement, drivers to transport dangerous goods within the province.

- Currently a driver licensed in any Canadian jurisdiction is qualified to drive vehicles according to a particular class of license anywhere in Canada. Concern expressed by other provinces regarding modification of standards included:

  - compromise to safety because of potential challenges to the National Safety Code Standards, because of the basis for these standards,

  - fears that medically unfit drivers would engage in inter-jurisdictional transportation,

  - the ability to honour commercial licenses from other jurisdictions, and

  - the gradual erosion of medical standards for commercial drivers.

- British Columbia is concerned that BC drivers of commercial vehicles would have difficulty crossing inter-jurisdictional borders if our hearing requirements were less stringent than those in other jurisdictions.

3.0 METHODOLOGY

3.1 Group Discussion

The Group Discussion is condensed into Summaries of the Committee's minutes. The subjects discussed by the Committee are not listed by the name of the member who presented the subject; however, responses to the subject are included with each item if offered by another member (see Appendix F).

3.2 Guidelines from International Jurisdictions

Most of the developed nations were contacted regarding hearing guidelines for commercial vehicle drivers. Those who replied are listed in Appendix G along with the recommended guidelines, examples of standards and the OECD perspective.

3.3 Literature

Literature reviewed by the Committee is provided in three Appendices: Appendices C, H and V.

3.4 Ethicist's Discussion

An ethicist from the Northern University of British Columbia was invited to speak on the role of ethics in decision making and to answer the Committee's questions (see Appendix I).

3.5 Report Prepared for the BC Ambulance Service

The BC Ambulance Services, Ministry of Health, has prepared a paper entitled "Issues Related to Profound Hearing Impairment in Paramedics and Ambulance Attendants" Excerpts from this paper are included in Appendix J.

3.6 Fire Fighter/Emergency Operator Duties

The Vancouver Fire & Rescue Services submitted two lists of tasks essential for fire fighters and fire engine operators (see Appendix K). According to Lorne Mutter, Training Officer,[5] these two lists of tasks are inseparable.

3.7 Bus Driver Survey

Questionnaires regarding the relationship between hearing and safe bus driving were distributed to BC Transit drivers, and Inter-provincial and Intra-provincial Passenger carrying Coach Lines, the results are located in Appendix L.

3.8 Train Whistle Detection Project Executive Summary

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[5] From telephone conversations, February, March and April 1998, there are no employers that are either fire fighters or operators, all personnel have to be both (i.e., staffing levels, budgets and practicalities).

An acoustical engineer was hired by the Office of the Superintendent to evaluate the audibility of train whistles from within a truck cab with the engine idling. The engineer concluded that train whistles are audible within the truck cab with the engine idling (see Appendix N).

3.9 Guidelines from Other Canadian Jurisdictions

All Canadian provinces have signed a Memorandum of Understanding (MOU) agreeing to honour the recommended National Safety Code medical guidelines. The MOU and provincial responses are located in Appendices M and O.

3.10 Variations within Canadian Jurisdictions

In respect to dangerous goods restrictions for Class 1 and 3 licences, there is one province (Ontario) that does not follow the MOU to honour the recommended hearing guidelines within the specific jurisdiction.

4.0 DISCUSSION

4.1 Comments from a Member of the Deaf Community

The Deaf Committee Member, Roger Carver, set forth general views held by himself and his colleagues that need to be reviewed by the Committee during its discussions (full text can be found in Appendix P). A summary of these views is as follows:

- Medical doctors are not experts on the functionality of deaf drivers.
- Audiograms are not accurate measures of a deaf driver's ability to drive safely.
- The hearing function is not an absolute requirement for safe driving.
- Restrictions on deaf drivers are arbitrary in nature and have no basis in scientific fact.
- Research regarding deaf drivers has yet to establish deafness *per se* as proof of unsafe driving.
- Restrictions based on the hearing function could be determined by the employer.
- Restrictions on deaf drivers are discriminatory in nature and based on negative attitudes towards deaf drivers.

The Office of the Superintendent of Motor Vehicles response to Mr. Carver's comments is listed in Appendix Q.

4.2 Evidence Gathered by the Committee

The Committee investigated the role of hearing as related to the functions associated with safe commercial driving. The main findings of this report are as follows:

1) There is scant research respecting driving and hearing loss. In particular, there is very little empirical evidence available to assess the risk of profoundly deaf commercial drivers. Although there is some information regarding hearing loss in drivers of passenger vehicles, concerns regarding the methodology have been raised.

2) There is some anecdotal information from the Deaf Community in favour of removing current restrictions from the licences of deaf commercial drivers.

3) There is significant anecdotal objection from professional commercial drivers regarding the removal of hearing-related restrictions from Class 2 and 4 (passenger for compensation) licences.

4) There are some technological devices or techniques to compensate for hearing loss or deafness, e.g. siren and horn detectors. The effectiveness of these devices has not been demonstrated (see Appendix V).

5) Driving and ability to perform job-related duties are part of the commercial driver's responsibilities, and they cannot be considered independently, because employers assume that the existence of a commercial licence implies meeting all medical guidelines regarding driver fitness.

6) British Columbia is linked by medical guideline reciprocal agreements with other Canadian and American jurisdictions regarding crossing provincial and international borders.

7) There is a BC legislative requirement for commercial drivers who transport dangerous goods or passengers, to "stop, look and listen" at uncontrolled railway crossings. The use of audio detection devices does not satisfy the requirements to "listen".

8) Train whistles can be heard over internal tractor truck cab noises, (Wakefield 1998)[6]. Therefore hearing drivers should be able to hear a train whistle before they see the train. The slow acceleration of a heavy vehicle increases the time needed to safely cross the tracks. This may place profoundly deaf drivers, passengers and others at increased risk of accident because of the consequent reduction in reaction time, where vision is obstructed.

9) The Superintendent has the authority to prescribe medical fitness guidelines for drivers, based on evidence supplied by medical experts. Medical fitness for drivers' standards is based on honestly held beliefs by medical experts.

10) The Superintendent has developed policies for passenger for compensation

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[6] Wakefield Acoustics Ltd, Highway Crossing Train Whistle Detection Project, Victoria, BC, 1998.

commercial drivers as a requirement of his/her responsibility to protect passenger and public safety. In particular, commercial drivers must be able to communicate readily with passengers and others in the event of an emergency.

11) Drivers who operate large passenger buses state that hearing is an essential component of their jobs, especially in regard to communication with passengers and others, i.e., dispatchers, co-workers, etc.

12) The literature available on the accident rate of deaf drivers is inconclusive.

13) With respect to public safety, the consequences of a commercial vehicle accident are such that medical fitness standards are more stringent than for private passenger vehicles.

14) There is great variation in the extent to which individuals can compensate for their hearing limitations.

15) In reference to medical and driving standards, individual driving assessments for profoundly deaf drivers who wish to transport dangerous goods, passengers and operate emergency vehicles are not practical for several reasons, including the danger inherent in the testing procedure, e.g., uncontrolled railway crossings and the lack of valid and reliable assessment protocols. Furthermore, there is no evidence that task performance during an assessment predicts road safety abilities with respect to profoundly deaf commercial vehicle drivers. The effects on deaf drivers of visual distractions, bad weather, unexpected incidents, unanticipated ambient noise on aided cannot be assessed safety and reliably.

4.3 Individual Human Rights Versus Public Safety

It may be argued that to prohibit profoundly deaf drivers from driving commercial vehicles in the absence of empirical data demonstrating an increased risk is discriminatory (see Appendix U). On the other hand, it is impractical to do individual assessments because no practical assessment tool exists[7]. Furthermore, the Superintendent believes it would be unethical to subject the population of British Columbia to an uncontrolled experiment where lives may be lost and untold hardship may be induced. Additionally, it would not be reasonable to disregard a hypothesis that is accepted by other developed nations.

The Superintendent is not in a position to deny the consensus of medical opinion in respect to the potential risk involved with profoundly deaf drivers and commercial vehicles[8] [9]. An individual assessment is impractical in the case of a Class 1 and 3

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[7] According to the Court of Appeal for British Columbia Decision, December 18, 1997 (Grismer), "There is no safe or reliable form of testing that can measure the ability to deal with unexpected or exceptional traffic situations. Simulating such situations for testing would be unacceptably dangerous", page 34.

[8] According to the Court of Appeal for British Columbia Decision, December 18, 1997, regarding a previous Human Rights Tribunal Decision (Grismer), page 30, "The

licence, emergency vehicles or uncontrolled railway crossings. Regarding Class 2 and 4 licences, a driver must be able to effectively communicate with passengers, the public, dispatchers, and emergency personnel, as well as meeting other stated requirements.

Additionally, the British Columbia Government could be held liable for driver at-fault accident damages by subjecting a population to a risk without their consent, where licensure occurred as a result of inappropriate changes to current policy.

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risk is obvious to the lay person and medical expert alike. Given the medical support for the Physician's Guide I do not think it was reasonable to diminish the risk because there was no accident figures".

[9] It is not reasonable "in requiring more evidence than what was available, especially when the reliability of the medical opinion, universally applied throughout Canada, was not discredited", from the Grismer BC Court of Appeal Decision, December, 1997, page 25.

5.0 SUMMARY

The mandate of the Committee was to investigate the role of hearing as related to the functions associated with safe commercial vehicle driving.

1) Regarding emergency vehicles, passenger for compensation vehicles and uncontrolled railroad crossings, hearing is an essential component of safe commercial vehicle operation (Note: dissenting opinion from Roger Carver). In particular, the current consensus of medical opinion in BC, national and international medical bodies support the current guidelines for hearing requirements. The British Columbia Otolaryngologist Society is reviewing its position on the decibel levels recommended by the NSC (see Appendix W). With respect to driving large trucks, the Committee could not reach a consensus on the issue of profoundly deaf drivers with a hearing loss in excess of current BC and NSC requirements.

2) After considering all of the information brought forward, the OSMV believes that there is insufficient justification to remove commercial licence restrictions for profoundly deaf drivers. Medical opinion, inter-jurisdictional agreements and guidelines and the opinions of commercial drivers, emergency vehicle agencies and the other information outlined in this report support the Superintendent's position. The Deaf Community does not believe that any restrictions because of deafness are justifiable.

3) No technological alternative to the pure tone audiogram has been accepted by any jurisdiction to determine whether deaf commercial drivers are medically fit to drive. However, some Committee members state that audiograms can not evaluate driver safety.

4) While certain audio detection devices may assist deaf drivers, no evidence demonstrating safety was brought to the Committee's attention. No developed nation has accepted these devices as substitutes for hearing. When proven safe and effective, audio detection devices may enhance driver safety in future.

5) There is insufficient justification to permit drivers who fail to meet current guidelines to transport passengers for hire. The Committee Member from the Deaf Community disagrees with this policy.

6) Commercial vehicle drivers who transport dangerous goods and passengers are legislatively required to stop, look and **listen** at uncontrolled railway crossings. Where vision is obstructed, deaf drivers cannot detect trains at uncontrolled crossings as quickly as hearing drivers. The OSMV assumes that the risk at uncontrolled railway crossing is excessive for deaf drivers relative to hearing drivers, thus the rationale for the legislated "listen" requirement in section 185 (4)(f) of the Motor Vehicle Act. The potential consequences of accidents involving dangerous goods and trains is also taken into consideration.

7) The roles of hearing and speech are critical and inseparable components of

emergency vehicle operators' job descriptions.

8) The Committee is unaware of any practical or safe way to determine which profoundly deaf drivers may safely operate commercial vehicles.

9) With respect to drivers with moderate hearing loss applying for Class 2 or 4 licences (excluding emergency vehicle operation) who fail to meet current hearing requirements, there may be a case for individual consideration, when all the following criteria are met and particularly when, the driver previously had an equivalent commercial licence in a developed nation:

   a. The driver can adequately communicate with passengers (comprehend speech with or without a hearing aid, and speak clearly), and is restricted to a vehicle designed to carry not more than ten persons, including the driver.

   b. The job does not involve the crossing of uncontrolled railway crossings.

   c. A commercial licence assessment is recommended by an audiologist and an Otolaryngologist (see Appendix S).

   d. The driver is able to demonstrate to a OSMV approved occupational therapist, who is trained in assessing fitness to drive, all of the following abilities:

      i can comprehend speech from a passenger at the rear of the vehicle while driving without turning his or her head,

      ii can effectively communicate using a phone or wireless device, and

      iii can detect and respond appropriately to vehicle sirens and horns.

Note: if a hearing aid is required to meet the hearing requirements, the potential masking effect of ambient noise should be assessed.

APPENDICES **PAGE**

Appendix A: Vehicle Types and Hearing Guidelines for Driver Licence Classification.

Licence Classification	**Permits Operation of the Following Vehicles**[10]	**Driver Hearing Guidelines - Guide for Physicians in Determining Fitness to Drive a Motor Vehicle, 7th Ed.**
Class 1	Any motor vehicle or combination of vehicles, but does not include operation of a motorcycle other than a limited speed motorcycle or an all terrain cycle.	Persons driving heavy commercial vehicles should not have an uncorrected hearing loss greater than 55 decibels, averaged at 500, 1000 and 2000 Hz in their better ear. Additionally, drivers who do not meet the National Safety Code hearing guidelines[11] should not have a corrected hearing loss greater than 40 decibels, averaged at 500, 1000 and 2000 Hz in their better ear.
Class 2	Any motor vehicle or combination of vehicles in class 4. A bus[12], school bus, special activity bus or special vehicle. A combination of vehicles without air brakes where the towed vehicles exceed 4600 kg.	Persons who drive passenger buses should not have a hearing loss greater than 40 decibels, averaged at 500, 1000 and 2000 Hz in their better ear. Drivers should be able to hear what their passengers are saying to them without having to turn their head and their eyes away from the road. Drivers should be able to hear sirens from emergency vehicles and warnings at railway crossings.
Class 3	Any motor vehicle or combination of vehicles in class 5. Any motor vehicle with three or more axles other than a bus when used for its purpose as intended by design. A tow car and its recovered vehicle. A mobile truck crane. A combination of vehicles where the towed vehicles do not exceed 4600 kg. A combination of vehicles without air brakes, where the towed vehicles exceed 4600 kg.	Persons driving heavy commercial vehicles should not have an uncorrected hearing loss greater than 55 decibels, averaged at 500, 1000 and 2000 Hz in their better ear. Drivers who do not meet the National Safety Code hearing guidelines[13] should not have a corrected hearing loss greater than 40 decibels, averaged at 500, 1000 and 2000 Hz in their better ear.

[10] *The British Columbia Professional Driving Guide*, Insurance Corporation of British Columbia, Vancouver, BC, Current Edition.

[11] Should not have a corrected hearing loss greater than 40 decibels, averaged at 500, 1000 and 2000 Hz in their better ear. If the driver needs a hearing aid to meet the standard, the licence must bear a notation stating "valid for Class # only when wearing a hearing aid".

[12] A motor vehicle having a seating capacity of more than 10 persons including the driver, that is operated for hire or for public transportation.

[13] Should not have a corrected hearing loss greater than 40 decibels, averaged at 500, 1000 and 2000 Hz in their better ear. If the driver needs a hearing aid to meet the standard, the licence must bear a notation stating "valid for Class # only when wearing a hearing aid".

Class 4 Restricted	Any motor vehicle or combination of vehicles in class 5. An ambulance or taxi[14]. A special vehicle[15]	Persons who drive passengers for hire should not have a hearing loss greater than 40 decibels, averaged at 500, 1000 and 2000 Hz in their better ear. Drivers should be able to hear what their passengers are saying to them without having to turn their head and their eyes away from the road. Drivers should be able to hear sirens from emergency vehicles and warnings at railway crossings.
Class 4 Unrestricted	Any motor vehicle or combination of vehicles in class 5. An ambulance or taxi. A school bus, special activity bus[16], special vehicle or a bus with a seating capacity of not more than 25 persons including the driver.	Persons who drive passengers for hire should not have a hearing loss greater than 40 decibels, averaged at 500, 1000 and 2000 Hz in their better ear. Drivers should be able to hear what their passengers are saying to them without having to turn their head and their eyes away from the road. Drivers should be able to hear sirens from emergency vehicles and warnings at railway crossings.
Class 5	A 2-axle motor vehicle other than a motorcycle, but does not include a bus, school bus, special activity bus, special vehicle, taxi or ambulance, when used for its purpose as intended by design. A 2-axle motor vehicle with towed vehicles where the towed vehicles in that combination do not exceed 4600 kg. A motorhome or motorhome with towed vehicles where the towed vehicles do not exceed 4600 kg. A limited speed motorcycle, all terrain vehicle or all terrain cycle. A construction vehicle. Notwithstanding the first sentence in this classification, a school bus that: - is a passenger vehicle as defined in Motor Vehicle Act Regulation 11.01[17], and - has a seating capacity of not more than 10 passengers including the driver.	There are no minimum hearing guidelines for passenger vehicle or light commercial vehicle (Class 5) driver licences.

[14] A taxi is a motor vehicle designed to carry not more than 10 persons, with its driver, and is operated for hire.

[15] A motor vehicle having a capacity of more than 10 persons including the driver, that is operated for hire or public transportation.

[16] A bus that conforms to the safety standards under the *Motor Vehicle Safety Act* (Canada) that are applicable to the bus on the date of manufacture. Is operated on behalf of, or at the request of, the authority in charge of a school. Is used for non-scheduled transportation.

[17] A motor vehicle that conforms to the safety standards under the *Motor Vehicle Safety Act* (Canada) that were applicable to passenger cars or multipurpose passenger vehicles under that *Act* on the date of manufacture of the motor vehicle.

Appendix B: Driving Tasks that Require Hearing, Robinson, G.S., Casali, J.G. and Lee, S.E., Role of Driver Hearing in Commercial Motor Vehicle Operation: An Evaluation of the FHWA Hearing Requirement, Final Report, Virginia Polytechnic Institute and State University, September 1, 1997.

Routine driving tasks:
Pre-trip inspection
Manoeuvring in light city traffic
Manoeuvring in heavy city traffic
Manoeuvring in light highway traffic
Manoeuvring in heavy highway traffic
Manoeuvring in light rural traffic
Up shifting
Downshifting
Detecting missed gears
Turning
Braking
Accelerating
Passing another vehicle
Being passed by another vehicle
Parking
Emergency stopping
Backing up to a loading dock
Going through a weigh station
Entering and exiting limited access highways, including weigh stations, rest stops and on/off ramps
Merging into traffic
Negotiating upgrades
Negotiating downgrades

Communication:
Making deliveries
Backing up to a loading dock
Weigh station communications
Communicating with the dispatcher
Listening to a CB radio, radio or tape deck
Communicating with other drivers on the CB

Detection of mechanical problems:
Tire blow-out
Other tire/wheel problems
Pre-trip inspection
Engine
Transmission/drive train
Suspension
Air pressure problems
Problem with trailer
Load shift

Detection of internal (inside cab) warning signals:
Low oil pressure
High oil temperature
Low water
Low air pressure
Engine temperature

Detection of external warning signals:
Detection of approaching trains
Detection of emergency vehicles
Detection of automobile horns
Detection of truck horns
Detection of a car in your blind spot
Detection of a car coming up on your left side
Detection of a car coming up on your right side
Detection of pedestrians, animals, and other unmarked road hazards
Detection of rumble strips
Detection of lane deviation
Detection of lane edge bumps

Engine
Adjustment or tune-up needed
Bad injector
Problem with turbocharger
Loose, worn or broken belts
Engine temperature high
Problem with water pump

Drive Train
Clutch problem
Transmission problem
Drive line, drive shaft
Universal joint
Differential problem
Axle problem

Brakes
None

Air system
Total loss of air pressure
Slow leak in air lines or fittings
Compressor problem
Air tank problem
Bad gauge
Bad warning buzzer
Air pressure too high
Tires and wheels
Tire blow-out

Bad wheel bearing

Electrical system
Problem with alternator

In addition to the list prepared by Robinson et al, commercial drivers who transport passengers-for-hire have other duties that require hearing, as follows:

Communicating with on-board passengers
Communicating with entering and exiting passengers
Communicating with emergency personnel, ie, police, ambulance, fire, etc

Appendix C Empirical Literature

1. Songer, T.J., LaPorte, R. E., Palmer, C.V., Lave, L. B., Talbott, E., Gigson, J.S., and Austin, L.A., Hearing Disorders and Commercial Motor Vehicle Drivers, US Department of Transportation, 1993.

   The US Federal highway regulatory system excludes drivers with a defined level of hearing loss from interstate trucking for public safety purposes. According to Songer et al, these stringent standards are based on sparse or methodologically weak data, but it is felt that relaxation of these standards to permit further study was not in the public interest.

   Auditory stimuli are important during the four following situations:

   1. Situations where warning signals need to be heard (sirens, horns and at railway crossings);

   2. Hearing vehicle malfunctions (brakes, tires and/or engine);

   3. During pre-trip vehicle inspections[18] (thumping tires, checking air brake lines, listening to vehicle start and warm up); and

   4. For communication (especially in emergency conditions).

Opponents of the established hearing standards for commercial drivers argue that:

1. Safe driving is almost all visual and hearing plays a smaller role;

2. Noise levels in trucks render hearing ability an insignificant safety factor due to masking;

3. Hearing impaired drivers can compensate for their deficiencies, and more recently;

4. New truck cab designs are more sound-proofed so even hearing abled drivers cannot hear external noise.

Risk Assessment (Songer et al, 1993)

There is very little research examining the impact of a hearing impairment on a commercial driver's ability to drive. One factor that limits research in this area is the very small population of hearing impaired commercial drivers (i.e., one in Arizona, two in Michigan and four in Oregon). In addition to the population size, accidents in general

[18] In British Columbia, drivers are required under section 37.22 of the Motor Vehicle Act Regulations (Division 37), to perform a pre-trip inspection before the first trip of the day (see Appendix T). This inspection includes tires, horn, gladhand (airbrake coupling) and other airline components of the air brakes.

are relatively rare events. Thus, comparisons of the accident rates between hearing abled drivers and hearing impaired drivers are virtually non-existent.

Most reports of hearing impaired drivers with lengthy accident-free periods are anecdotal in nature and thus, unreliable. Studies that show greater hearing loss is associated with lower crash records are also unreliable, as the drivers were older. Hence, it would be difficult to determine whether the safe driving records were a result of driving experience or due to more cautious driver behaviour.

Basically the issue is whether the benefits[19] of employing individuals with disabilities outweighs the risks. The risks include a higher incidence of accidents and the associated injury and economic costs, and there is also the cost associated with monitoring programs for the disabled driver.

Drivers with afflictions such as diabetes, epilepsy and heart disease are monitored by licensing agencies. The concern is that drivers can be subject to a sudden incapacitation that will negatively impact driving abilities. On the other hand, hearing-impaired drivers are continually limited by the inability to hear. Hearing is one of four senses[20] used by a driver to interpret messages from the external environment. A review of current literature does not prove or disprove that hearing is required for safe driving, but hearing plays very significant role during non-routine driving situations.

Given the uncertainty of relative crash rate estimates, using the available data, the authors conclude that the crash risk for a hearing impaired driver is between 0.7 to 2.0 times that for a normal hearing driver.

2. Henderson, R.L. and Burg, A., The Role of Vision and Audition in Truck and Bus Driving, Federal Highway Administration, Bureau of Motor Carrier Safety, December, 1973.

The Bureau of Motor Carrier Safety of the US Federal Highway Administration is responsible for the establishment of minimum visual and auditory standards for interstate commercial vehicle operation. The commercial drivers interviewed for this study reported that a deaf driver would not be as safe as a non-deaf driver. The drivers indicated that hearing provided the first cue to potentially dangerous situations, often associated with equipment malfunctions and on occasion in association with the location or behaviour of another vehicle. The use of hearing while driving does not appear to be a conscious or deliberate act, thus drivers may discount its importance. But most stated that they would not drive with earplugs or earphones (presumably to dampen the engine noise). The drivers did not want to miss hearing any vehicle malfunction that could lead to a serious safety problem. Drivers appear to listen for different sounds; they may listen for specific sounds or they may listen for changes to

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[19] From the traffic safety perspective, there are no benefits associated with allowing a deaf individual to drive commercial vehicles.

[20] The four senses are vision, hearing, touch and smell.

the current or usual sound pattern.

The authors contend that whether a warning noise (siren) is heard is relative to the masking noise in a truck cab, 70 dB (engine slowly idling) to 90 dB (truck in active motion), rather than on any hearing loss by the driver short of complete deafness. Thus, audition contributes most to driving performance during off-the-road tasks in a relatively quiet environment.

An audiometer was used to measure the hearing capability of 236 drivers (102 were bus, 129 were truck and 5 were supervisors). These drivers all volunteered and they all worked for firms that had progressive management and active safety programs. It is questionable whether these drivers were representative of the population, i.e., drivers with known or suspected visual or auditory deficiencies may not have volunteered and these firms may have had stricter requirements for selection and retention of drivers.

The truck drivers were found to have consistently greater hearing loss than the bus drivers. This difference could be a result of the noisy truck cabs or due to the fact that the mean age of the truck drivers was somewhat greater than for the bus drivers. No driver in either group had a hearing loss greater than 40 dB in the better ear. The results indicated that greater hearing loss was associated with fewer accidents. The authors had two explanations for this result. First, hearing is not important to safe driving. Or second, the existing qualification standards adequately screened out the drivers whose hearing was so poor that they were unsafe drivers. The only way to determine which explanation was correct would be to relax the present standards and study the effect on accident statistics. This approach would not be in the public's best interest and the available research could not support such a decision.

3. Motor Carrier Safety: Physical Qualifications of Drivers with Respect to Hearing - Federal Highway Administration [49 CFR Part 391], Federal Register, Vol. 41, No. 248, Thursday, December 23, 1976.

This document was produced to announce the denial of the petition by the State of Wisconsin, Department of Health and Social Services to allow deaf drivers to drive interstate commercial vehicles. The petitioner contended that: 1) Safe driving is almost totally dependent on visual acuity and alertness; 2) Safety records of deaf drivers are superior (i.e., handicapped drivers compensate for their loss); 3) Noise levels in large over-the-road tractors renders hearing totally insignificant as a safety factor; and 4) Disallowing deaf drivers from interstate commercial drivers is discriminatory. Although the petitioner backed the arguments with research reports, it must be noted that the methodology in these reports was weak (i.e., subjects were not representative of the population they were to represent).

The opponents to the petition based their opposition on the following:

- drivers should be able to hear warning sounds (e.g. sirens, railroad grade crossing alarms);

- in heavy traffic and urban areas, the low speed of the engine would not produce

sufficient noise to mask emergency or warning signals;

- drivers should be able to hear mechanical noises associated with malfunctions or faulty equipment;

- drivers should be able to effectively communicate in emergency situations (sign language would not be sufficient, nor would writing in adverse conditions or at night) or by telephone with the carrier[21];

- hearing is crucial when hazardous or petroleum products are involved (i.e., tank shutdown orders, malfunctioning pumping equipment or during emergency situations). Tank Truck companies are subject to stiff penalties for spills into the environment; and

- carriers would be subject to more public liability and recovery actions.

A literature review and a questionnaire sent to every state licensing agency examined the relationship between hearing acuity and driving. The result was that there was no existing statistical record kept by any state, but hearing was considered to be important to driving by the respondents. The only comprehensive and well-controlled study quoted in this report was the second study by Coppin and Peck (1964). These authors reported that deaf males have 1.8 times more accidents than non-deaf males, but there was no significant difference for violations. Coppin and Peck concluded that in certain types of driving circumstances hearing might be an important sensory modality.

Another study quoted in this report was done by the Wisconsin Department of Public Instruction (1974). This study concluded that: 1) In respect to violations, law enforcement officers may be more lenient with deaf drivers and thus only charge in respect to severe violations and, 2) The hearing impaired driver tends to have an accident rate nearly twice that of a non-hearing impaired driver.

In addition to hearing, the ears provide orientation sensing, movement detection and balance. Thus, these other symptoms associated with some forms of hearing loss could adversely affect a driver's performance. The vibrations or severe joltings experienced while driving a commercial vehicle could aggravate the driver's already compromised sense of orientation and balance.

The US Department of Transportation justifies the establishment of qualifications for employees of motor carriers by way of highway safety regulations as follows:

> We emphasize safety in our decision of minimum qualifications which, if we err at all, should err on the side of preservation of life and limb. And although our research and statistics collected cannot establish to a certainty that hearing is needed to assure safe transportation of commerce, we should not be expected to establish this to a certainty, if certainty would require running the risk until a tragic accident would prove that the original judgement was sound.

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[21] Carrier refers to a trucking company.

Of the 50 comments filed in regard to the petition, 34 opposed allowing deaf drivers to operate interstate commercial vehicles, 10 supported the petition, and 6 did not support or oppose but asked for further research. Those opposed based their decisions on the deaf driver's inability to hear warning signals, inability to hear mechanical malfunctions and communication in emergency situations. Although there is a possibility that standards may be too stringent, any relaxation of these standards to prove more conclusive evidence would not be in the public interest.

4. The Totally Deaf Driver in California: Part II - Coppin, R. S. and Peck, R. C., California Department of Motor Vehicles, 1964.

This is a follow-up report to an earlier study "The Totally Deaf Driver in California: Part I (1963)". The original study did not properly control for other variables such as mileage and occupation. Thus, Part II controlled for confounds by matching the deaf and non-deaf subjects on variables other than deafness[22]. The subjects, 170 males and 140 females, were matched on age, annual mileage, occupation and gender. The same subjects were also matched on area of residence for a subsidiary analysis.

The deaf subjects were either totally deaf or the hearing ability was so minimal as to be non-functional for daily purposes. Statistical analyses compared the two groups of drivers to see if there were significant differences between the number of traffic violation and the number of reported accidents. For female drivers, there were only small differences in violation and reported accidents. The male drivers did not significantly differ in violation frequencies, but when matched for area the deaf drivers had 1.8 more accidents than their non-deaf counterparts.

Coppin and Peck suggest that there are certain driving situations where hearing is important and the lack of hearing would be a handicap.

5. Robinson, G.S., Casali, J.G. and Lee, S.E., Role of Driver Hearing in Commercial Motor Vehicle Operation: An Evaluation of the FHWA Hearing Requirement, Final Report Virginia Polytechnic Institute and State University, September 1, 1997.

In the United States, the Federal Highway Administration has established guidelines for interstate commercial vehicle drivers. Individual states have their own guidelines for commercial vehicle drivers who operate solely within the licensing state.

A research program was undertaken to determine whether a hearing requirement is necessary for commercial drivers, and if so, whether the requirement is set at the correct audiometric level. The research report was a two-part process. The first was an extensive literature review, and the second was an extensive task analysis.

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[22] Note: the subjects were not commercial drivers.

To summarize the literature review, the results of the early hearing studies had no conclusive findings as to the role of hearing in safe driving. Many of the early studies were found to be methodologically unsound. The studies that were more controlled are consistent, i.e., accident rates ranged from 1.78 to 1.82 times that of hearing drivers (Cook, 1974; Coppin and Peck, 1963: Coppin and Peck, 1964).

In addition to reviewing studies of the hearing task and driving, this report also looked at the relationship between noise, hearing level and accident rate. The relationship between these three variables was found to be unclear. The effect of truck cab noise was examined, as well as the validity and reliability of the forced whisper test. The forced whisper test was found to be invalid and unreliable, thus the authors recommended the use of pure-tone audiometry tests to establish hearing level.

The second part of this research report was the commercial vehicle task analyses. The report outlines the Hearing-Critical Commercial Vehicle Operator (CVO) Driving tasks, as obtained by questionnaires completed by 80 truck drivers. To verify this list of critical tasks, personal interviews were held with 11 commercial vehicle operations experts (SME's - Subject Matter Experts). From the results gathered from these personal interviews, the authors supported the argument that commercial vehicle driving should be classified as a hearing-critical job.

<u>The drivers' who completed questionnaires and the SME's conclusions regarding the role of hearing in driving are summarized as follows:</u>

1. There are many tasks that require truck drivers to use their hearing, e.g. communication, detection of internal and external warning signals, and detection of mechanical problems.

2. Hearing is both important and necessary for the safe operation of commercial vehicles.

3. Hearing requirements should be set at 13 decibels below the masked threshold of the quietest noise condition. If the frequencies with contemporary audiometers are to be retained, the levels should be set at 45 dB for 500 Hertz, 45 dB for 1000 Hertz, and 40 dB for 2000 Hertz.

4. The forced whisper test must be considered an outdated mode of screening truck drivers for hearing damage or loss.

<u>The authors recommendations in regards to hearing standards are as follows:</u>

1. Warning and advisory signals should contain their primary energy to the 700 to 3000 Hertz frequency range.

2. The forced whisper test cannot be advocated, but they recommend the use of audiometers.

3. The minimum range of frequencies to be tested is from 500 Hertz to 4000 Hertz (specifically, 500, 1000, 2000, 3000 and 4000).

Appendix D: Provincial Hearing Guidelines for Commercial Vehicles

PROVINCE	NFLD	PEI	NS	NB	PQ	ONT
DANGEROUS GOODS RESTRICTION	yes	yes	yes	yes	yes	yes (except for several deaf drivers who currently transport Dangerous Goods within the provincial borders)
SUMMARY	Follow the CMA[23] and NSC[24] guidelines.	Follow the NSC guidelines.	Follow the NSC guidelines and have listed medical impairments to driving in regulations. Driver must be able to hear a forced whisper at no less than 5 feet.	Follow the NSC guidelines.	Follow the NSC guidelines.	Follow the NSC guidelines (several exceptions, see column above).

[23] The Canadian Medical Association "Physicians' Guide to Driver Examination" recommends that Class 2 and 4 (passenger carrying vehicles) drivers should have a corrected hearing loss of no more than 40 decibels averaged at 500, 1000 and 2000 Hz. There are no hearing standards for class 1,3,5, or 6 licences, but transporters of dangerous goods should meet the hearing standards for Class 2 and 4 licences.

[24] National Safety Code recommends Class 2 and 4 (passenger carrying vehicles) drivers should have a corrected hearing loss of no more than 40 decibels averaged at 500, 1000 and 2000 Hz. There are no hearing standards for class 1,3,5, or 6 licences, but transporters of dangerous goods should meet the hearing standards for Class 2 and 4 licences. If an individual requires a hearing to meet the standard, the licence should bear a notation such as Avalid for Class # only when wearing a hearing aid.

PROVINCE	MAN	SASK	ALB	BC	YKN	NWT
DANGEROUS GOODS RESTRICTION	yes	yes (see Summary)	yes	yes	yes (see Summary)	yes
SUMMARY	Follow the NSC guidelines	No hearing standards for class 1 except for dangerous goods. A driver may get special permission to haul dangerous goods from SGI	Follow the NSC guidelines	Follow the NSC guidelines	Drivers cannot have a hearing loss greater than 50 decibels at a frequency of 2000 cycles per second in both ears, regardless of hearing aids. Thus, there are no profoundly deaf drivers with a higher class license in the Yukon.	Follow the NSC guidelines

Appendix E: Motor Vehicle Act section 185 (4)

MVA s. 185 (4) reads as follows. *Except at a railway spur line or an industrial track in a business or residence district, the driver of*

(a) a bus carrying passengers for compensation,
(b) a school bus carrying a child,
(c) a vehicle carrying explosive substances or any poisonous or flammable substance as cargo, or
(d) a vehicle used to carry flammable liquid or gas, whether or not it is empty, approaching a railway crossing that is not protected by gates or railway crossing signal lights, otherwise directed by a flagger, must
(e) stop his or her vehicle
(i) no closer than 5 m, and
(ii) no farther than 15 m from the nearest rail of the railway,
***(f) remaining stopped, must listen and look in both directions along the railway for an approaching train, and for signals indicating the approach of a train,** and*
(g) must not proceed until he or she can do so safely.

Appendix F: Group Discussion

September 29, 1997

- Standards have to be derived from honestly - held beliefs. In the area of disability, standards have to be warranted, not subjective.

- There may be no place for medical experts on this panel, as they are not driving experts nor are they experts on how to live as a deaf person.
  RESPONSE: The member didn't necessarily mean there is no need for doctors, but there is a bigger role for the deaf community in setting standards.

- There is a tradition to set standards to address a problem that arises, thus standards may be arbitrarily imposed.
  RESPONSE: There is a need to address the safety issues associated with deaf drivers and the public, when developing appropriate standards.

- There needs to be evidence that deaf drivers poses more of a threat than other drivers.
- Most jurisdictions have restrictions for deaf commercial drivers.

- The number of deaf drivers is very low which leads to the low number of accidents. Of the 15,000 driver medical exams received in one year, only 60 were requested because of deafness.
  RESPONSE: Because the deaf comprise a relatively small population, it is difficult to have good quantitative studies.

- There is a need to look at Class 4 licence requirements. Standards could be developed by the employer rather than OSMV.
  RESPONSE: Given economics, the employer may not have the luxury to care for the employee or society.

- The OSMV has been given the responsibility by government to ensure all drivers are safe drivers. This is especially true for passenger carrying vehicles, if the driver needs to communicate with passengers.

- The purpose of the Committee as described in a previous Human Rights mediation is to review licensing standards as related to hearing loss and establish if there is any functional link between safe driving and hearing.

- Where there is no "crisp" data, the Committee needs to review everything and exclude nothing that references this issue.
  RESPONSE: The Committee needs to identify areas that are a concern to the purpose of the Committee, i.e., the OSMV is concerned about safety whereas the Deaf Community wishes to remove employment barriers.
  RESPONSE: Are standards developed for the safety of the individual, are they for pubic safety, or for both? The OSMV mandate is to protect public safety.

- The Committee has to be mindful of the Human Rights issue and have to justify with evidence that treating deaf drivers differently is justifiable. The two questions that need to be answered re a) are deaf drivers more at risk, and b) does a standard have to be set or is an individual assessment needed?
  RESPONSE: When considering relative risk, there is not a lot of evidence that deafness puts people at any higher risk than many conditions that are not subject to standards. Currently there is no assessment tool.

- Regulations are a relative problem, therefore the Committee needs to focus on benefits or abilities, rather than limitations.

- There is a need to know relative risk, therefore careful determination is needed before jumping from small numbers to large numbers (of drivers). The OSMV should be cognizant of what tools to compensate for hearing loss are available and reasonable, and where that technology is obtainable.

- It is difficult to have standards, not all deaf people compensate equally. There needs to be an assessment process before restrictions are imposed.

- In an industrial situation, the Workers Compensation Board is concerned that employees respect each other's safety.

- There have been several individual assessments of monocular drivers.
  RESPONSE: Monocular drivers need to be assessed as to their compensatory abilities. In respect to the deaf, although there are siren detection drives, some may use them well while others won't.

- Deaf commercial drivers may have to be restricted to driving commercially only in BC.

- The terms of Reference developed by this Committee would just be for BC.
  RESPONSE: The Terms of Reference could be used by other jurisdictions as a model for standards.

- Individual assessments are expensive, i.e. several thousands dollars for each. The OSMV does not have the funding available and the costs of these assessments are not covered by the Medical Services Plan. Is a user-pay system feasible?
  RESPONSE: Other accommodations (i.e., ramps) are paid for by the government and/or the employer.

- There is a need to develop standards to reduce the number of people who need to be assessed.

- There is a need to develop different categories of deaf, i.e., length of time deaf, other injuries, etc.
  RESPONSE: People who are born deaf have a different cultural upbringing than

those who are recently deaf. The cultural factor is a bigger factor than hearing itself, as it can influence one's perspective of how driving should be handled.

- The legal counsel for the deaf driver, who precipitated this Committee, wants no restrictions placed on deaf drivers. The hypothesis is that hearing is not a function of driving.

- The BC Physicians Guide for Determining Fitness to Drive is skewed as the experienced drivers are only represented by hearing drivers.

- The dangerous goods restrictions outlined in the National Safety Code do not relate to hearing, nor was the importance of hearing addressed.

November 26

Several considerations proposed for deaf drivers were as follows:

- Perhaps new technology (i.e., flags, lights) could be used to compensate for hearing limitations.

- Professional driving is a job description issue rather than a licensing issue.

- Some deaf organizations/individuals advocate that early onset/congenital hearing loss can compensated.

- It was suggested that deaf long haul truckers have a partner to assist with possible communication problems.

- Possible solutions/issues regarding the detection of audio cues:

  a) devices that can detect horns/sirens, air leaks

  b) ambient noise in the truck may mask external noises

  c) drivers with early onset deafness may adapt better to hearing loss

  e) detection of audio cues is not an issue with correction (hearing aids)

- With a cochlear implant, there may be situations where an individual can't make out the conversation, but can hear the sound. This ability varies between individuals.

- There can be fluid build-up with a head cold, which can range from 0 to 40 dB's (average 28.5 dB).

- The purpose of committee is to focus on aspects of safe driving.

- Drivers can use a tachometer to detect a missed shift. Mechanical problem

detection can be dealt with devices, feel G force and vibration.

- The driver is responsible for pre-trip mechanical checks. Other ways to detect mechanical problems include:

  a) soap solution to check for bubbles resulting from an air leak.

  b) other devices could be used, such as, pressure gauges and flags.

  c) while there is an air gauge in truck cab, there may be a slow leak that does not register.

  d) There are electronic devices that let you know if each brake is functioning.

- Is it reasonable to assume that road noise will mask air leaks?

- Commercial licences as a whole need to be looked at, i.e., apnea, cardiac, etc.
  RESPONSE: The Office of the Superintendent of Motor Vehicles (OSMV) will have to look at all medical conditions and hearing could serve as a framework.

- There are Federal standards for such safety devices as low air detectors and flags. These standards are based on the size of the vehicle and are required as "new" by the Federal and Provincial governments.

- School buses have to stop, look and listen at unmarked railway crossings. There are devices to detect sirens, but not train whistle/horns.
  RESPONSE: Perhaps all school buses should have warning device for sirens i.e., kids are noisy.
  RESPONSE: Other commercial drivers don't necessarily stop/look/listen, and don't need to turn down stereos, therefore, don't need to "single out" deaf drivers.

- The Human Rights Standards for Reasonableness of an action require:

  a) honestly believed to be necessary,

  b) has to be based on objective criteria and

  c) if there is objective evidence, there still needs to be accommodation.

- Two employer issues with Motor Vehicle Act, section 185 (4)(f):

  a) is there a liability issue, i.e., can the employer be sued if an employee does not comply with this legal requirement, and

  b) employers may use this MVA section to not hire deaf drivers.

- Deaf commercial drivers now drive without following MVA section 185 (4)(f), so this

issue is moot. As well there are different types of train horns.

- The recent Supreme Court decision regarding use of interpreters (Elderidge) demonstrates hearing is not a blanket "thing", it requires individual assessment.

- With propane tanker trucks, there is a concern for leaks in tank itself, thus is not restricted to the relief valve.

- Detection of external noise is an issue for all drivers, i.e., maybe none can hear over engine noise, perhaps all drivers need a device. Considering gas leaks, gases already have a smell that is used to detect leaks.

- In reference to communication, deaf drivers can use cell phone and TTY to check weather conditions. With TTY conversion, an operator can be contacted with a cell phone and there is a coupler to the TTY keyboard.

- In regards to changing the legislation to suggest "listen" ,may audio devices be included, it takes years to go through the process?

- Law enforcement has certain discretion to the application of the law.

- In consideration of the Safety Focus:

    a) deaf drivers already drive commercially, and

    b) it is important if the risk increases.

- In reference to the Memorandum of Understanding (MOU) signed by members of the Canadian Association of Motor Transport Administrators (CCMTA), no dangerous goods can be transported between Canadian provinces by deaf drivers. The only solution may be that BC will have to restrict deaf drivers to BC to honour signed agreements.

- The difference between BFOR[25] & BFJ[26] is as follows:

  - BFOR refers to employment situations

  - BFRJ refers to non-employment situations

- Direct discrimination is open and admitted. The only acceptable defences are BFRJ/BFOR.

- OSMV is essentially an employer, i.e., the standards are like hiring standards but not all people are the same. Thus, to provide the service it must be equally accessible to all people. If there are exceptions, OSMV must identify why there is a denial or restrictions to the licence.
  RESPONSE: The Courts reference to case law "what if" defences are insufficient, i.e., should be supported by objective evidence as to the actual risk. It is difficult to define time or medical evidence that a risk is X.

- If safe driving functions are spelt out for all drivers, and meet the objective test, then the driver has the onus to demonstrate ability to meet those functions, i.e., electronic devices. If there are exceptions, OSMV must show that the function is reasonable.

- Justification can not be arbitrary, it has to:
  a) be objective,

  b) apply to all, and

  c) be reasonably necessary.

- Is there a reasonable accommodation that can be made to allow disabled people meet this requirement (devices, individual assessments)?

- Accommodations made in past for deaf now benefit all, e.g., ramps, side mirrors. Thus, hearing devices for external noises will benefit all drivers.

- Issues to be considered:
  a) need to change MVA section 185 "listen" , and

  b) need to define "listen".

- Hearing qualifications by licence class:

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[25] *Bona Fide* Operational Requirement

[26] *Bona Fide* and Reasonable Justification

Licence Class	Hearing Guidelines	Qualifications
Class 1	yes	uncorrected 55 dB
Class 2	yes	uncorrected 40 dB
Class 3	yes	uncorrected 55 dB
Class 4	yes	uncorrected 40 dB
Class 5	no	
Class 6	no	

- In reference to uncontrolled railway crossings:

  a) Do you need to hear? RESPONSE: Yes, according to the law. Also, visibility may not work in all situations.

  b) What is the appropriate level of audibility at the crossing? RESPONSE: The Committee will determine the audibility level of using a truck (engine on and off) at a crossing to check dB level.

  c) What is the accommodation?

- The Committee will have to look at standards and the individual, i.e., look at 40 dB of hearing loss for the higher class licences. Is it possible to test sirens/horns?

- Hearing issues to be resolved include the detection of train whistles, sirens, and hear/understand passengers.

- Does deaf community think totally deaf people should drive buses with 40-50 people. Is it a common sense issue?

- Greyhound and other bus drivers will be interviewed regarding the use or need for hearing as part of their jobs.

- Hearing standards shouldn't be turned over to employers.

- Congenital versus acquired deafness need to be assessed.

- Why do we need a standard? RESPONSE: OSMV follows BCMA standards arising from public safety concerns.

- The Committee needs to supply evidence: statistical, test results, testimonial, expert opinion, and observations as to the role of hearing in the safe operation of a commercial vehicle.

- When considering testing, the able-bodied have only one test versus disabled people who pay more than one fee.

- Who pays for individual assessments? RESPONSE: Suggest that if the driver passes, OSMV pays, and if the drivers fail, they pay.
  RESPONSE: OSMV should pay until they can demonstrate undue hardship from specialized testing and individual assessments.
  RESPONSE: Perhaps the "who pays" issue is a cart before the horse issue and it may create unemployment for the deaf.

- Many deaf drivers want a Class 4 licence, i.e., Deaf Youth Association. A hearing driver may need signing ability when transporting 12 to 15 people.

February 5, 1998

- The issues discussed at the February 5, 1998 Committee meeting are summarized below with comments when offered.

- Ann presented the results of the Bus Driver Survey.
  RESPONSE:
  a) the bus driver survey results are subjective, because none of the drivers were deaf, thus they wouldn't know how a deaf person would react to various situations,
  b) the results are biased as the hearing drivers are unfamiliar with the compensatory abilities of the deaf, and
  c) the number of subjects (bus drivers who responded) are too small to draw conclusions regarding the role of hearing in safe operation of a bus.

- Ed presented a Draft Discussion Paper.
  RESPONSE:
  a) Class 4 licences are not limited to the sole act of driving, there are passenger safety concerns, and
  b) An analogy would be the seat belt requirement, i.e., wearing a seat belt does not help one to drive, but is a component of traffic safety.

- In regards to the transportation of dangerous goods, there is no study comparing deaf drivers to hearing drivers.
  RESPONSE: The commercial driver deaf population is too small to produce a valid or reliable study.

- Although the probability of an accident involving a deaf commercial driver could be low, the risk would be considered high (as the consequences of such an accident would be great).

- A Committee member commented that concerning the Hodson complaint, the dangerous goods restriction was not related to safe driving.

- There was agreement among the Committee, that commercial driving is just not the "actual act of driving", there are interconnected tasks, e.g., securing loads prior to departure.

- There were strong reservations expressed by most of the Committee concerning deaf drivers operating emergency vehicles. RESPONSE:
  a) effective communication between a deaf driver and a partner (also patient and dispatcher) is not practical,
  b) a request was made to examine the functions related to the safe operation of an ambulance, and
  c) the basic requirements of driving an ambulance include, effective communication, ability to drive safely at high speeds, and while driving at high speed in emergency situations the driver must have the ability to keep his eyes on the road.

- In regards to Hussey, the OSMV does not feel that the complaint has been directed properly, ie., the deaf driver wishes to transport one deaf client, who lives with the driver. It is possible to do this with a Class 5 licence, however, the group home society requires the driver to have a Class 4 licence. RESPONSE: The OSMV will contact the society to see whether this policy can be discussed and possibly amended.

- Legal counsel has advised OSMV that "listen" means with the ears, not detect sound with an audio detection device. RESPONSE:
  a) Can the Committee get a copy of this opinion?, and
  b) The train whistle detection device is not expected to be tested and available for at least two years, thus, changing the legislated "listen" requirement would be premature.

- If the typical bus driver cannot sign, how can he communicate with a deaf passenger? RESPONSE: The difference in the sizes of the hearing and deaf populations would not necessarily lead to signing requirements for all bus drivers.

- Driving is not the real issue here, it is the other job requirements associated with the safe transportation of passengers.

- Although it has been suggested that deaf drivers compensate by relying on vision or have better vision, there is no evidence to support these suggestions.

- Mr. Hodson's lawyer, Henry Vlug, wants all driving restrictions removed from deaf drivers.

- Communication and other job requirements are not related to driving. What is safe operation of a vehicle?

- There are problems with the current hearing standards. Could individual assessments be a solution to these problems?

- In respect to bus drivers needing the ability to communicate with passengers, double-decker bus drivers cannot hear the passengers on the upper level.

- The Committee's report will look at each issue, contain the Committee's discussion, list restrictions with reasons, discuss risks (without quantifying risks) and include statements from the concerned parties if relevant.

- Under the Human Rights Commission and the Freedom of Information Act, the report will be made public.

- It was suggested that the hearing guidelines should be gradually phased out rather than dropping all restrictions at once, ie., based on five year reviews of the guidelines, availability of new technology, etc.

Appendix G: International Commercial Licence Hearing Guidelines

COUNTRY	United States	Sweden	Australia	France
SUMMARY	There are Interstate medical requirements Driver must be able to hear a forced whisper in the better ear at not less than five feet with or without the use of a hearing aid. The average hearing loss in the better ear cannot be greater than 40 decibels at 500, 1,000 and 2,000 hertz. If the driver can only meet the criteria with a hearing aid, the driver must wear the hearing aid at all while driving and carry a spare power source.	Deaf drivers are restricted from driving passenger-carrying vehicles. Deaf drivers cannot drive a bus or a taxi. Drivers must be able to communicate with passengers and other road users if a normal tone of voice can be understood from a distance of 4 metres in one ear, with or without a hearing aid.	Passenger carrying drivers must be able to communicate with passengers above ambient noise without turning their head. Commercial drivers are expected to be able to hear changes in road and engine noises, horns, sirens, rail crossings and emergency signals. A conditional licence may be considered for drivers whose corrected hearing meet the following safety requirements: average hearing loss in the better ear cannot be greater than 40 decibels at 500, 1,000, 2,000 and 3,000 hertz.	Profoundly deaf drivers excluded from commercial transport. The hearing loss cannot be greater than 35 decibels in a range up to 2000 hertz. The driver must be able to hear a whispered voice beyond one metre and a loud voice up to five metres. A temporary permit can be issued to a driver whose hearing can be restored to these standards by a prosthesis or surgery. A specialist's opinion or psychiatric exam may be required to detect possible mental impairment.

Continued on the next page

COUNTRY	Finland	Luxembourg	Germany
SUMMARY	For commercial vehicles whose maximum permissible weight exceeds 3,500 kg, the driver must be able to hear a normal conversation at 4 metres, with at least one ear, with or without a hearing aid. For passenger vehicles with eight seats or more, the driver must be able to hear normal conversation at 4 metres with at least one ear.	Issue or renewal for categories C and D driving licences is refused if the driver is hindered by poor hearing when driving a motor vehicle. A Class D licence is not issued or renewed if the applicant wears a hearing aid.	Extremely deaf drivers (proven loss of hearing of 60% or more) with three years experience driving a vehicle weighing up to 3.5 tons with trailers up to 750 kg can drive the other heavier commercial vehicles in the commercial vehicle class, except they cannot transport passengers.

Appendix H: Anecdotal Information

Various anecdotal evidence regarding deaf employees in traditionally hearing careers was obtained from the *Silent News* publication, *Deaf Life*, the *book Silent Alarm* and the *NAD Broadcaster* (National Association for the Deaf). The excerpts with short summaries from these publications are listed below:

1) "Deaf EMT's New Moral Phenomena: Are They Essential to Our Survival?", *Silent News*, January 1997. -- This article gives a brief history of the few deaf emergency workers, mostly employed with rural Emergency Medical Services and Volunteer Fire Departments. The article lists possible scenarios that negatively impact deaf individuals in emergency situations, as follows:

   a) Deaf patients are beyond the training scope of EMT's student training. The situation may intimidate an EMT and deaf patients can be deferred to lesser-quality ambulance services.

   b) Each deaf patient is unique in that their response to the medical responders is fear and the responders may be fearful or reluctant. Society tends to be paternalistic towards the deaf.

   c) Medical attention or police protection can be impacted by communication difficulties.

   d) There are questions related to the effectiveness of a 911 system and the adherence to the law in providing equal access to emergency services for Deaf people.

A deaf EMT employed with a combination nursing facility and private ambulance was interviewed. The worker wanted people to understand that Deaf people would have to overcome job barriers. Her only frustration was her reliance on another EMT for interpretation of radio calls.

2) "Deaf EMT's New Moral Phenomena: Are They Essential to Our Survival?", *Silent News*, February 1997. -- An interview with another deaf EMT who expressed hardships she has overcome in her personal and work life, i.e., partners afraid to work with her. She does not think she poses a danger to her partner or a patient. She has accommodated limitations by use of an amplified stethoscope, can hear asthma-induced course wheezing and has her fellow EMT confirm lung sounds after assessing the patient.

3) "Devices Make Driving Safer for Deaf and Hard of Hearing People", *Silent News*, February 1997. -- An announcement of two alerting devices. First a dash mounted emergency vehicle siren detector that has one to four warning indicators to illuminate how close the emergency vehicle is to the person's car. Second, a turn signal reminder that intensifies in frequency the longer the signal is left on. It also has a buzzer that is much louder than a normal signal reminder.

4) "Using a Cellular Phone with a TTY", *Silent News*, February 1997. -- An announcement regarding a direct connect TTY to be used with cellular phones and the equipment needed to connect the phone to the TTY.

5) A letter to the Editor regarding Truck Noise, *Silent News*, September 1995. -- A letter commenting on the semi-truck restriction for deaf drivers, which questions the ability of a hearing people to hear above the truck noise.

6) "Deaf Nebraska Fireman is One of the Boys", *Silent News*, September 1995. An article regarding a deaf Volunteer Fire Fighter in Nebraska. His only drawback was an interior fire where he could not see his fellow fire fighters.

7) "Deaf EMT Follows in Family's Footsteps", *Silent News*, December 1995. -- A review of a book entitled *Silent Alarm: On the Edge with a Deaf EMT.*

8) Steven L. Schrader, *Silent Alarm: On the Edge with a Deaf EMT*, Gallaudet University Press, 1995. (excerpts). This is an autobiographical account of the 15 years experienced by a deaf fire-fighter and EMT. Due to a profound hearing loss the author did not meet the physical requirements for the Georgia State Fire-fighter Standards and Training Council. He convinced the Volunteer Fire Chief to hire him, despite not meeting the medical requirements. The author did not notify his Emergency Vehicle Operation instructors that he was deaf (could hear with hearing aids and was a proficient lip reader) and they assumed he had a speech impediment. Throughout Schrader's career he was subjected to discrimination from co-workers and on one occasion from a police officer. Schrader discusses the limited experience most EMT's have with deaf patients and the potential for risk if inadequate communication between the deaf patient and hearing EMT is a factor. He suggests that classifications of deafness should not be limited to audiological variations, but should include individual differences in the deaf, i.e., education, ability to communication, family support.

   The author had two intentions in writing this book. First, to educate people regarding the pre-hospital problems faced by the deaf. Second, to outline the numerous obstacles and limitations he had encountered as an emergency worker. Discussing the ability for a deaf person to become a fire-fighter or an EMT, Schrader made the following comments:

   a) A fire-fighter or EMT requires some residual hearing and the ability to communicate verbally.

   b) Consideration must be taken in regards to the safety of the patient and the partner.

   c) Each member of an EMT crew has a specific set of responsibilities and the partner cannot be expected to do the work of two and at the same time provide quality care. It might mean the difference of life and death for both patient and crew.

   d) There are radio communication problems. If the deaf EMT is doing CPR and the hearing EMT is communicating by way of the radio while driving, the driver can't pull over to assist the determination of breath sounds prior to initiation of treatment.

   e) The one technological device available (in additional to a hearing aid) to Schrader was a device that gave visual readings for heart, pulse, breathing rates and blood

pressure.

f) He often had difficulty hearing breath sounds such as rales, wheezing and congestion when the siren was in use.

g) To compensate for the masking noise of the siren, Schrader would turn off his hearing aids, use them as earplugs while using the stethoscope to listen to the patient.

h) There was no device that could provide digital readings of breath sounds to aid in the determination of shortness-of-breath complaints.

i) Radio communication was difficult unless signals and codes were used instead of regular conversation. Or the partner would assist with radio communications.

If Schrader had to become an EMT over again, he wouldn't do it. He stated the impacts on his health were too great (i.e., headaches, memory loss, nervousness, loss of balance and severe tinnitus).

9) "Cathy Noble: The First Deaf Campus Police Officer", *Deaf Life*, November 1993. An interview of Cathy Noble regarding her personal life and 20 week co-op position as a campus safety officer. Now a Masters of Social Work Graduate student, Noble discusses the impact of the Campus Safety officer job on her self-esteem and the impact on others, both deaf and hearing. As to exposure to person-to-person situations, she would sign and vocalize her words. If the hearing person had difficulty understanding she would write or have her partner vocalize for her. In regards to radio communication, Noble could not hear, and speech was understood after some initial problems (people had to get used to her voice) and the use of repetition.

10) "Taking the Checkered Flag", *Deaf Life*, June 1992. This is an interview with Russell Errigo, a deaf auto racer. Errigo was born deaf with a 90-100 dB hearing loss. He comes from a supportive family and has learned to speak well. He is a self-described "risk-taker" who tests himself by doing dangerous, "daredevil" things. Errigo speaks to pit crew and has a TDD (TTY) donated so that the pit crew can speak to him. However, the TDD is not installed due to scrambling trouble and "burndowns" in experimental runs.

11) "Hearing and Deaf, Each May be Viewed Differently", a reprint from the *NAD Broadcaster*, Rosalyn Rosen. The author expresses a comparison of how attitudes reflect what people think, feel and act differently towards the attributes and actions of Deaf and Hearing people.

Appendix I: Ethicist's Discussion

Dr. Debra Poff, ethicist and Vice President of the Northern University of British Columbia presented ethical and social contents and answered questions. During the discussion, Dr. Poff explained the differences between Consequentialism and Deontology; i.e., Consequentialism emphasizes Rights of the Individual, whereas Deontology focuses on Rights of the Public.

Consequentialism is another term for utilitarianism, which states the principle that, in all circumstances, we should strive for producing the greatest possible balance of value over disvalue for all persons affected (or the least possible disvalue if only bad results can be achieved). This cost/benefit analysis approach justifies any decision if the decision produces more good than any alternative would. In regards to Rights, freedom is primary and the principles encourage laws that protect individual rights while not harming others.

In contrast, Deontology principles states that the ends never justify the means. Rules are universal, formal and absolute.[27]

Dr. Poff stated that, when considering traffic safety risk, although the probability may be low, the consequences could be higher. When considering sufficient risk, sufficient refers to reality, not the degree of risk. When asked whether the employer or the OSMV should set medical standards, Dr. Poff stressed the OSMV mandate is to serve the public good, whereas a corporation's primary concern is profit.

When Dr. Poff was asked who should pay for individual assessments, the response was that the service providers had to, unless it results in undo hardship. The example of undo hardship was the provision to supply interpreters for university students. The financial burden of supplying interpreters may impose an undo financial hardship on the university, thus the university should not be required to pay.

Two questions remained to be answered at the end of Dr. Poff's presentation, as follows:

1) Is the listening requirement at train tracks direct discrimination?

2) When considering transporting school children, what input does the public have?

In regard to the two questions raised by Dr. Poff the following comments could be appropriate:

1) The direct discrimination with a *Bona Fide* Reasonable Justification application applies to the hearing restrictions issue. The hearing policy or rule was developed and applied in good faith, and is the sincerely held belief that it is necessary to protect public safety. Additionally, the objective element applies in that the policy is necessary to assure an

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[27] Note: In contrast to Consequentialism, the Deontology concept of cost/benefit analysis would be stated that nonmaleficence (non-infliction of harm) takes precedence over beneficence (production of benefit) when they come into conflict. Thus, one does not necessarily determine what is good, but seeks to find the greatest balance of right over wrong.

efficient job performance that does not endanger the driver, co-workers, or the general public.

Regarding the degree of risk, the sufficiency of the risk is considered to related to the reality of the risk, not the degree, i.e., considering the evidence brought forward to the Committee the risks are real, however, determining the degree of risk would be impossible without inadvertently exposing the public to potentially inherent harm.

2) When an adult (person who has reached the age of legal maturity) decides to be a passenger in a vehicle, the decision is based on the adult's reasoning process or judgement. For example, the person may decline to drive with an intoxicated driver, either in a passenger or commercial vehicle. However, minors or people without adult reasoning abilities tend to have safety decisions made by parents or guardians. In this context, informed consent regarding a driver who does not meet requirements of licensure should be mandatory.

Appendix J: *Issues Related to Profound Hearing Impairment in Paramedics and Ambulance Attendants*, by S.E. Martin, MD, for Dr. Harv Haakonson, British Columbia Ambulance Service, April, 1998.

Paramedic and Ambulance Driver jobs are at times and in certain situations interchangeable. Accurate speech reception and transmission are necessary components of successful ambulance teamwork. There are several interconnected driving, paramedic functions associated with the communication aspects of these jobs, such as:

a) to be able to use all senses, especially hearing, to evaluate a patient's status in an emergency situation;

b) to be able to verbally relay that information between several individuals; and

c) to be able to listen to a variety of sounds sources simultaneously, ie., monitoring devices, breath sounds and other co-workers.

A study[28] quoted by the author of this report states that there is a definite correlation between industrial accident risk and base line or induced hearing loss. This risk can extend to co-workers in close proximity to the hearing impaired worker. Furthermore, the effects of a hearing impairment creates anxiety and stress in co-workers, especially in emergency situations.

Martin concludes that "profound hearing loss represents an impairment that can not adequately be compensated for by assistive devices or behaviour in the environment of an ambulance or in the occupation of a first response Paramedic/ambulance driver . . . The functional requirements of a Paramedic/ambulance driver are hearing critical. . . It would seem to be in the best interests of the patient or potential passengers (ride along nurse, physician, respiratory therapist, etc) to require optimum hearing ability in drivers of ambulances and paramedics. . . **For these reasons, it is my opinion that a profoundly deaf person should not be permitted to act as a first line responder, paramedic or drive an ambulance".**

[28] Hetu, R., Riverin, L., Lalande, N., Getty, L., St-Cyr, C., "Qualitative analysis of the handicap associated with occupational hearing loss", *British Journal of Audiology*, Vol. 22, pp. 251-264, 1988.

Appendix K: Fire-Fighter/Emergency Operator Duties

Fire-fighters need to:

< hear at fires/incidents that are extremely noisy and poorly lit
< be able to locate victims under those circumstances
< be able to see, feel or hear their partner
< be able to locate fire-fighters by the sound of their Pass Alarm
< communicate by radio
< hear and see well when their air bottle warning device is low
< have all equipment colour coded and be able to determine the colours

If a Fire-fighter cannot hear and/or see well, how can your partner and/or team rely on them 100% regardless of the situation you may be in?

Operators need to:

< hear well
< see engine controls under poor conditions
< hear problems with engine or pumps before it shuts down
< hear, when drafting, small air leaks in hard suction
< be able to prevent cavitation[29] by hearing changes in engine RPM and sound of water through fire pump
< understand the captain's commands from a distance
< hear the primer[30] in operation (no lights or anything to indicate that it is working)
< hear well while wearing the SCBA[31]
< hear horn on engine while taking the hydrant

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[29] Formation of partial vacuums in a swiftly moving liquid.

[30] A device to initiate priming.

[31] Self Contained Breathing Apparatus

Appendix L: Bus Driver Survey

Task Analysis Questionnaire[32]

Background information: N = 137 (68.5% response rate)

Age X = 47.3 range = 30 to 64

Gender male = 127 female = 10

Bus driving experience, in years: X = 18 years range = 2 mos to 40 years

In kilometers driven per week:

Now: X = 1220 kilometers per week

At maximum X = 1787 kilometers per week

Related experience (ie, dispatcher, supervisor) Respondents = 30, range 2 mos to 25 years

1. Do you feel that hearing is important for the safe operation of a bus?
   99.3% Yes 0.7% No

2. If you feel it is important, do you also feel that it is necessary?
   99.3% Yes 0.7% No

3. Do you sometimes drive with the window down?
   85 %Yes 15 % No
   If yes, how often?
   7% Always 67% Often 25% Seldom 1% N/A

4. Does external noises prevent you from hearing requests or questions from your passengers?
   50% Yes 50% No

5. Which of the following audio devices do you use while driving the bus?
   CB radio 4% Tape/CD player 10% AM/FM radio 12%
   Cell phone 10.3% Radio link/audio link to dispatcher 49%
   Other audio devices, please list:
   Public Address System, 6% Chimes 7% VCR (for passengers) 4%

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[32]Robinson, G.S., Casali, J.G. and Lee, S.E., Role of Driver Hearing in Commercial Motor Vehicle Operation: An Evaluation of the FHWA Hearing Requirement, Final Report, Virginia Polytechnic Institute and State University, September 1, 1997. The questionnaire contained in Robinson et al (1997), Appendix A, has been modified to reflect the British Columbian bus drivers' situation.

6. Do you have any known hearing loss? 15% Yes 47 % No 38% No Response
If yes, how would you categorize the loss?
70 % slight 30 %moderate severe
Have you had a hearing aid? 4% Yes 96% No
When was your last hearing test? 52 % have been tested, range 1 month to 20 years
What type of test was it?
83 % Audiometric (headphones) 13 % Whisper test 4 % Other (unknown)
What was the result? Responses ranged from: good, okay, high pitch gone, slight and moderate loss
Do you own a hearing aid? 4% Yes 96% No
Do you wear a hearing aid while driving the bus? 2% Yes 98% No
Do you wear a hearing aid when not driving the bus? 3% Yes 97% No

7. Check any of the following hobbies you have been involved in:
27 % participation in or live attendance at car races, tractor pulls, etc
17 % hunting
17 % target shooting, skeet shooting, etc
30 % wood working, metal working
43 % using a chainsaw, gas-powered trimmer, gas-powered leaf or snow blower
33 % riding an all-terrain vehicle, motorcycle or snowmobile
17 % other noisy hobbies concerts, dancing, fireworks, flying, outboard motors, drums, and Fire Department

8. Check any of the following occupations you have pursued:
18 % military 15% lumber or furniture industry
0.7% boiler operator 1.4% quarry operations
9% machine shop 13% automobile or truck repair
20% other noisy occupations fishing, engineer, fire fighter, aviation instructor, fireworks supervisor, car wash, trucker, construction, stevedore, music, steel mill, train crew, assembly line, and mining

9. Check any of the following boxes any of these hearing protection devices questions apply to you when you are exposed to noise:
At work? 18% Yes 46% No 36% No Response
In leisure activities? 43% Yes 35% No 5% No Response
Type worn 29% Earmuffs 43% Ear plugs
Brand/model worn (if known) Peltor H10A, Decidamp, Glycerin, Grinder protection, foam plugs, E.A.R. Defenders, custom fitted plugs, and E.A.R. plugs.

Questionnaire:

Please rate the importance of each of the following driving tasks to safe driving (Column 1), and then rate the importance of hearing to the completion of that task (Column 2), where: **1 = Very Unimportant, 2 = Unimportant, 3 = Unsure, 4 = Important, and 5 = Very Important.** Circle the choice that best corresponds to your opinion.

	Column 1 Importance of **TASK** to safe driving					Column 2 Importance of **HEARING** to completion of task				
Routine driving tasks in %:	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Pre-trip inspection	6	1	-	9	84	11	9	7	34	39
Maneuvering in light city traffic	5	2	4	98	60	5	2	12	34	47
Maneuvering in heavy city traffic	6	-	1	14	79	1	1	3	31	64
Maneuvering in light hwy. traffic	5	1	4	31	59	5	4	13	32	46
Maneuvering in heavy hwy. traffic	5	1	1	18	75	2	1	1	30	65
Maneuvering in light rural traffic	2	-	4	21	73	2	4	8	25	61
Turning	8	3	2	27	60	8	11	24	26	31
Braking	5	1	2	27	65	5	11	17	31	36
Accelerating	4	4	7	28	57	5	9	17	30	39
Passing another vehicle	5	2	6	17	68	4	8	11	31	46
Being passed by another vehicle	5	3	8	25	59	5	4	11	37	43
Parking	5	3	10	35	34	8	3	10	26	53
Emergency stopping	5	1	5	15	74	11	4	15	23	47
Backing up	6	1	2	12	79	6	5	5	13	71
Entering and exiting limited access highways, including:										
Rest stops	8	3	5	24	60	7	8	10	37	38
On/off ramps	6	3	3	22	66	5	10	8	32	45
BC Ferry Ramps	7	3	4	17	69	7	5	12	22	54
Merging into traffic	5	2	4	20	69	7	6	10	23	54
Negotiating upgrades	4	4	10	27	55	5	12	14	16	53
Negotiating downgrades	5	3	6	27	59	3	4	8	29	56

Questionnaire, continued: **1 = Very Unimportant, 2 = Unimportant, 3 = Unsure, 4 = Important, and 5 = Very Important.** Circle the choice that best corresponds to your opinion.

Column 1 Importance of **TASK** to safe driving. Column 2 Importance of **HEARING** to completion of task

Communication %:	1	2	3	4	5	1	2	3	4	5
Communicating with the dispatcher	8	6	8	32	46	5	1	2	20	72
Listening to a CB radio, AM/FM radio tape/CD player or emergency audio alerts N/A=9%	15	5	10	24	46	11	3	5	28	53
Communicating with other drivers on a CB radio, other bus-to-bus audio system N/A=5%(hear)	11	9	15	24	41	9	1	12	33	52
Communicating with passengers N/A=5%	7	5	9	33	33	5	1	2	19	73
Communicating with entering and exiting passengers	4	1	5	35	55	1	1	-	4	94
Communicating with emergency personnel, ie, police, ambulance, fire, etc N/A=5%(hear)	7	-	2	15	76	5	-	2	14	79

Detection of mechanical problems:	1	2	3	4	5	1	2	3	4	5
Tire blowout	4	1	-	13	82	2	5	5	12	76
Other tire/wheel problems	5	1	-	18	76	4	2	5	21	68
Pre-trip inspection N/A=7 %	6	1	3	16	67	7	5	5	30	53
Engine	3	-	4	30	63	3	2	4	26	65
Brake problems	5	-	2	14	79	3	-	5	19	73
Transmission/drive train	5	3	4	24	64	3	5	4	24	64
Suspension	5	2	8	23	62	5	9	11	26	49
Air pressure problems	5	2	7	9	77	5	5	8	9	73
Fluid problems	2	2	5	17	74	8	10	15	16	51

Detection of internal (inside cab) warning signals:

	1	2	3	4	5	1	2	3	4	5
Low oil pressure	5	3	4	21	67	8	5	11	23	53
High oil temperature	4	5	5	21	65	8	8	14	21	49
Low water	4	6	5	13	72	9	9	13	21	48
Low air pressure	5	2	2	13	78	8	2	6	18	66
Gearbox temperature	5	5	8	25	57	8	8	18	23	43
Engine temperature	4	3	4	23	66	10	8	13	22	47

Questionnaire, continued:

1 = Very Unimportant, 2 = Unimportant, 3 = Unsure, 4 = Important, and 5 = Very Important. Circle the choice that best corresponds to your opinion.
Column 1 Importance of **TASK** to safe driving. Column 2 Importance of **HEARING** to completion of task

Detection of external warning signals %:

	1	2	3	4	5	1	2	3	4	5
Detection of approaching trains	5	1	2	8	84	5	3	2	11	79
Detection of emergency vehicles	5	1	1	6	87	5	-	2	8	87
Detection of automobile horns	5	-	2	13	80	4	1	2	15	78
Detection of truck horns	5	1	2	15	77	5	-	2	13	80
Detection of a car in your blind spot	5	-	3	9	83	5	5	9	5	76
Detection of a car approaching from **behind**	5	2	6	20	67	9	15	20	15	41
Detection of a car coming up on your **left** side	5	1	2	26	66	8	17	16	24	35
Detection of a car coming up on your **right** side	5	1	3	23	68	8	17	24	27	24
Detection of pedestrians, animals, and other unmarked road hazards	3	-	3	10	84	5	9	13	2	71
Detection of rumble strips	5	1	6	21	67	7	18	25	16	34
Detection of lane deviation	5	3	12	23	57	11	19	28	15	27
Detection of lane edge bumps	5	2	11	23	59	12	18	26	14	30

New technology:

Are any of the following new technologies included as standards equipment on your bus? If so, is there a sound or hearing component of the technology?

Have available or use?		**Hearing component?**	**Not Applicable**
22%	Cellular phone	Yes	78%
1%	GPS(Global positioning system)	Yes	99%
12%	Computer interface with main office	Yes	88%
2%	Electronic navigation aid	Yes	98%
1%	Collision avoidance system	Yes	99%
1%	Electronic trip recorder	Yes	99%
20%	Mayday/distress system for emergencies	Yes	80%
1%	Drowsiness detection system	Yes	99%

Mechanical Problems:
When the following mechanical problems are encountered, how do you first detect their occurrence?
Circle V for Visual, H for Hearing, S for Smell, F for Feel or Handling, O for Other, or NA for Not Applicable

Engine (%)	V	H	S	F	O	NA
Loss of Coolant/low coolant	50	33	5	2	2	8
Low oil	50	30	1	1	1	3
Adjustment or tune-up needed	8	33	5	27	1	26
Bad injector	7	25	5	32	5	26
Problem with turbo charger	8	32	5	26	2	27
Loose, worn or broken belts	32	35	1	3	5	25
Engine temperature high	50	27	4	9	2	8
Dirty air or fuel filter	24	11	3	18	8	36
Problem with water pump	21	29	4	35	4	10
Loose engine mount	8	26	1	35	4	26

Drive Train (%)	V	H	S	F	O	NA
Transmission problem	5	28	7	44	1	15
Tie rod end worn out	2	12	-	62	2	22
Drag link problem	2	15	-	53	2	28
Drive line, drive shaft	1	27	-	48	2	22
Universal joint	2	31	-	48	5	14
Differential problem	2	35	-	31	12	20
Axle problem	4	30	1	42	5	18

Brakes (%)	V	H	S	F	O	NA
Overheating	8	6	58	11	1	16
Worn brake pads	10	40	3	39	1	7
Warped or cracked drums	13	15	1	46	7	18
Brake cam bearings worn	15	15	1	30	11	28
Problem with slack adjusters	17	6	1	71	3	2

Mechanical Problems:

When the following mechanical problems are encountered, how do you first detect their occurrence?

Circle V for Visual, H for Hearing, S for Smell, F for Feel or Handling, O for Other, or NA for Not Applicable

Air system (%)	V	H	S	F	O	NA
Total loss of air pressure	26	39	1	8	-	26
Slow leak in air lines or fittings	12	69	1	4	1	5
Water or oil in airline	18	12	1	23	10	36
Compressor problem	18	57	1	2	2	20
Air tank problem	18	60	1	2	5	14
Bad gauge	64	2	3	-	4	27
Bad warning buzzer	15	64	1	1	1	18
Air pressure too high	63	20	1	1	1	14

Tires and wheels (%)	V	H	S	F	O	NA
Tire blowout	1	57	1	26	-	15
Flat tire - no blowout	15	11	-	61	-	13
Worn tires/flat spot on tire	36	6	-	50	-	8
Bad wheel bearing	4	47	2	30	4	13
Bent rims	34	2	-	46	5	13
Loose lug nuts	66	4	-	18	1	-

Electrical system (%)	V	H	S	F	O	NA
Lights burnt out	98	1	1	-	-	-
Problem with alternator	66	16	2	3	8	5
Bad battery	53	10	13	10	7	7
Short circuit in lighting system	82	1	15	-	2	-
Worn Wires	60	-	15	6	2	17

Emergency vehicles and trains:

How do you first detect the following events? Do your **first Hear it (H) or see it (S)**? Does the detection method differ by time of day?

	Night		**Day**	
Train approaching crossing	H (60%)	S(40%)	H (91%)	S (9%)
Police car	H (97%)	S (3%)	H (90%)	S (10%)
Ambulance	H (74%)	S (16%)	H (86%)	S (14%)
Fire truck	H (79%)	S (21%)	H (87%)	S (13%)

Are you concerned about your ability to hear sirens, horns, horn whistles, pedestrians, bicyclists, etc while driving a bus?

99% Yes 1% No

Are you concerned about your ability to detect the needs of your passengers while driving a bus?

99% Yes 1% No

Critical driving incidents:

Can you think of any particular examples in which you feel that your hearing played an important role in a critical driving situation, either because you could not hear something, or because you did hear something? If so, please describe each incident as fully as possible. Some examples of critical driving events are: tire blowout, a passenger in distress, involvement in an accident, avoidance of an accident, severe mechanical problems, emergency vehicle behind you that you didn't hear, traffic violation, and brake failure. (Use back of sheet if more room is needed.)

- Detecting the presence of potential black ice formation, by listening to the sound that the tires make on the road, while passing over water that is partially freezing.
- A cracked wheel bearing.
- Can hear loose wheel nuts "groan" when brakes applied.
- I have experienced all of the examples given above. I had a lady on bus #10 who had a seizure and the only way I knew she was in distress is that I heard her banging her head on the window.
- I drove the #14 bus when the tire blew out, the angle of the bus did not change. Hearing it blow was the only way I knew I had a flat.

- Passenger handbag stuck in the back doors and ready to pull away. If the passenger didn't yell, I would have dragged the passenger.
- On many occasions I have stopped the bus because of hearing an emergency vehicle without seeing it first.
- I stopped my bus after leaving a bus stop because passengers yelled that a passenger was being dragged outside the bus in the back doors. The bus was full and the back door could not be seen.
- I don't usually see ambulances or police vehicles until I have already heard them, which gives me the time I need to take appropriate action.
- Faulty compressor, compressor was staying in the load stage, just expelling with no drop in pressure on the gauge. The possible failure of the compressor was not heard by driver.
- Backing bus up in a BC Transit yard, another bus sounded his horn indicating a possible contact with a small car. No accident took place.
- Loaded logging truck running a red light due to loosing his brakes - sounding his horn I was able to stop so he could run red light safely.
- Listening to engine on a slippery downgrade you can hear the engine drop to idle as the drivers break loose. Slight throttle can recover contact.
- I could hear a passenger's respirator begin to malfunction.
- Passengers' needs always require hearing, as in driving attention has to be on the road.
- Passengers on ventilators have specific sounds to warn driver of malfunction.
- Missed seeing other vehicle in blind spot when changing lanes. Other vehicle sounded horn to avert accident.
- Fire truck and ambulance especially in cities, you always here them coming (from behind) even before you see them in your mirror.
- Loss of air pressure (brake) due to Isolated Emergency Air Tank valve came open en route, heard air warning device (buzzer) as low air pressure light bulb was burnt out.
- At an uncontrolled railway crossing blind spot, heard the train whistle before the crossing even though I was prepared to stop, icy condition, took extra precaution because of the train whistle.
- I had a passenger suffer a serious illness. By hearing other passengers yell from the

middle to rear of coach, I was able to recognize the situation and summon help immediately without delay.

- When driving a truck, I was notified by CB at the top of a grade not to descend. There had been an accident on a blind corner on a 8.5% grade blocking the road. By not hearing the message on the CB, I would have started down the grade. By the time I would have come up to the accident scene, I believe I would not have been able to stop in time to avoid it. Hearing that CB avoided an accident and possibly saved my life.

- Passenger in the back of the bus had a drug related seizure. After hearing the commotion, I stopped the bus and was able to help the individual complete seizure in a safe manner.

- Front tire developed a rapid leak, which I heard and was able to pull bus to safety before it deflated completely.

- Heard a loud bang and found that the bus engine threw a belt, stopped before engine over heated.

- While driving westbound on Highway # 1 and passing through Lytton, I first heard a pulsating hissing. I quickly observed the air gauge inside the bus. I noted that there was no apparent air loss from the air system. I immediately pulled over onto a wide pull off and got out, discovered that there was an air loss on the driver side steering tire. Within a minute the tire was completely flat, there was no chance of handling the bus.

- While driving through Sicamous westbound, there was a loud bang like a gun going off. I wrote it off as maybe a backfire from another vehicle or an owl hitting the bus. After coming to a stop at the depot a very careful inspection was done on all tires. It was discovered that the driver's side rear dual had a large hole in side-wall facing out. When the bus was driven for a couple of miles to the depot there was no other noise, feeling with handling. If the trip would have been continued the flat tire would have heated up and totally failed, thus rupturing all the airlines and air bellows on that side.

- While driving I heard a low hum of conversation toward rear of bus. Every few moments there was foul language used. No one came forward to complain, but this behaviour was not acceptable. People do not always come forward to complain fearing retribution or some kind of backlash. I had to take the initiative and announce using the PA system that this kind of behaviour was not acceptable.

- Driving through Lytton, there was a loud thumping sound coming from the rear of coach. After pulling over at the next pull off I discovered that a piston rod had come through the side of the engine. There was oil all over the hot engine and engine compartment. Had I not heard the clunking and stopped accelerating, then come to a complete stop, there could have been a fire.

- Too many close calls. Hearing & seeing most important at all times.

- I was stopped at a light, up a upgrade behind a large truck. There were cars right

behind me. The truck started rolling back onto me. I honked the horn but still the truck hit the front of my car. The driver said he heard no horn--if he had heard the horn he could have stopped in time!

- Approaching intersection of Kingsway & King Edward - eastbound on Kingsway. Heard an ambulance but could not see it ahead or behind. It was coming east on King Ed and could not be seen until it reached the intersection.

- When carrying passengers who use breathing aids, either portable oxygen or those on respirators, you need to be alert to the built in alarms. The portable oxygen emits an alarm if tipped on its side. Respirators usually emit a loud alarm if they stop working, however if there is no alarm you need to be alert to the passengers emergency signal which is usually a clicking of the tongue.

- Was driving a vehicle that began making an abnormal sound when making a turn, as the day went on it became more pronounced. I pulled the vehicle off the road for an inspection and discovered the frame was cracked on both sides and was in danger of complete failure.

- Universal joint broke while on freeway. First heard the loud noise and knew something was wrong. Was able to pull over and then vehicle shaking started while changing lanes.

- Buzzer to indicate low air went off alerting me before I got too far from garage. Buzzer to indicating overheating went off enabling me to pull over before engine died (on Hwy #5).

- Dispatcher called to assist another driver having an emergency.

- It cannot be stressed enough for the ability to hear when operating a coach in and out of the garage, but depot or other congested areas you have blind spots and have to rely on hearing more than sight to know when danger is happening such as a cab engine racing behind bus at depot or baggage handlers pushing carts, or people walking behind or beside bus.

- In city driving, in Vancouver, emergency vehicles often do not approach from a line of sight, and one first becomes aware due to the siren!

- In a blowout, the first indication has been a loud bang followed by vibration.

- Minor incident: Engine quit running (mechanical problem) while going through a major intersection. The lack of accelerating nose told me there was a problem even before I could feel its affects.

- Training coming (whistle) before I could see it. Rural area, blind spot intersection or the Rail Road and the highway - uncontrolled crossing in Alberta.

- Stopping (countless times) at an intersection even though I had the green light to proceed because of impending approach of an emergency vehicle. Heard sirens before visual contact.

- The hearing of the bus driver ahead of me in a downtown bus stop prevented what would have been a fatality. A male fell of the sidewalk bench, under the bus, ahead of the dual wheels. By pumping my air brakes & honking the horn the other driver stayed stationary until I pulled out this person.

- Hearing a tag axle tire blowout, I was able to pull over and raise the tag axle before fragments from the tire casing ruptured the air brake line.

- Tire blown heard tire cap banging under bus before visual observation.

- Tire chain broke loose, on right hand side, could hear chain banging against side of coach.

- Proceeding down highway at highway speed--engine shut down (lack of coolant) not hearing engine sound was first indication of problem.

- On several occasions with emergency vehicles coming and going through intersections.

- On several occasions also I have detected that my tires have picked up nails or screws and even shards of glass, which I have heard while driving. In closing I don't have any problems with people with hearing impairments as long as their hearing aids enable them to hear everything that is a safety concern while operating a transit vehicle.

- North bound Granville bus drove over rubber bungee cord with steel hooks which lodged in right rear outer tire--and the flapping sound scared the pants off of everyone on board. (It sounded like a flat tire only louder as it bounced in wheel well).

- Rainy day, wiper going, fans on, emergency vehicle came right behind me. I did not hear them.

- I have been alerted of potential problems by other drivers honking their horns on numerous occasions over the years.

- Pulled over for ambulance and started up after it passed not realizing a second ambulance followed a block behind. Did not consider that there could be two sirens at once.

- I have had a tire blow out - after the initial sound, I immediately slowed to a safe stop - rear blowouts are not felt in the steering wheel.

- In crowded buses - problems with passengers in distress may not be visible but first heard, then, look for the source of the problem.

- Sudden loss of air is always heard first before noticing the gauges unless on highway – then low air gauge is noticed first.

- In city traffic - daytime - emergency vehicles are always heard first - long before they are seen.

- On one coach years ago the sensitive edge of the door failed. I caught a passenger in the rear door. If it was not for other passengers yelling at me I could have driven away with the passenger dragging behind.

- Ambulances, police cars, fire engines -- all of these vehicles you 'hear' long before you see. Hearing is one of most important tools we use while driving coach, next to vision of course!

- Tire blowout (has a distinct sound and knew what it was without actually seeing it).

- Emergency vehicle approaching from around blind corner (could hear siren before actually seeing vehicle).

- Vehicle running red light (sounded horn as it traveled through intersection).

- During a full trolley trip with passengers standing, headed uphill, pulled into bus stop to unload. Heard a loud BANG! Then felt bus shudder and air leak from rear air supports (AIR BAGS).

- Driving a bus towards the University and suddenly heard passenger fall to the ground and who then had an epileptic seizure. Immediately called for ambulance who arrived quickly and took her to hospital.

- Rush hour traffic 3:00 PM on a Friday. Fully loaded bus. I was pulling into bus stop slowly only to hear a "thump" on side of bus. I quickly looked only to see a male falling to ground on sidewalk near rear dual tires. I quickly slammed on brakes but his leg was caught and broken by the force of the tire. I called for police and ambulance who arrived quickly to take male to hospital. If I had not heard him I would probably have run right over him and killed him.

- The following three comments are from a driver who self-reports moderate hearing loss and use of a hearing aid while driving:

  - Did not hear fire truck because of very noisy defroster.
  - Did not hear emergency vehicle. Because of noise defroster and wipers. Early winter.
  - On board accident. Did not hear fire truck due to noise from defrosters, heaters and wipers.

- All 3 of the following incidents could say that accidents have been avoided either by

hearing a horn or screeching brakes, or both, and then defensive action has been taken once alerted by sound to the situation. This has happened a number of times over the years.

- Drive axle or axle tires going flat, (not blowouts) could hear the tire thumping. The sound was the only indication of the flat
- Cracked brake drums, again sound was only indication of defect.
- Air brake component failure usually detected during pre-trip inspection air system check when only indication was the air-leak sound.

- Sometimes I miss a car in my blind spot and the only way I don't swipe them is because they blast their horn.

- A person who uses a respirator uses various signals to indicate distress and the need for help, some of these signals are auditory, such as tongue clicking and the respirator beeping.

- You must be able to both ask a person's name and be able to hear their pronunciation of their name. Our clientele is very multicultural and elderly, and many have speaking disabilities. All of these factors impede their pronunciation and make it difficult for even a hearing person to understand. The confirming of a name or destination often required several attempts.

- Often, as I have windshield wipers, heaters and defroster fans on during rainy days quite often I am unaware if a passenger has asked me a question. Because of this I visually keep my eyes moving to mirrors and aware of passengers body language (standing next to me without moving back).

- No incidents, but it is important to be able to hear your customers to answer questions (ie. Which bus do I take? Where do you go?)

- Flat tire (felt it)

- Child at back of bus 3 years old got her thumb stuck in the washroom door hinge and the scream alerted me and the parent of the serious situation. The child's thumb was detached.

- Passenger placed her cup of tea on the window ledge. When the bus pulled around the corner the tea of course fell of the ledge and the "blood curdling" screams of boiling water scalding someone will never be forgotten.

- Birds, bats, moose etc. all banging into the bus creates a sound that alerts the driver of potential damage and startles the driver.

- A transport coming towards me in the opposite lane runs over a piece of metal on the highway. The metal lodges itself through the floor of the baggage bin dragging on the highway as it rips a hole in the bus. The sparks and sound of the metal alert me to the seriousness of the problem.

- I have had passengers over the years suffer from any number of emergency medical problems including heart attack and seizures it has been essential to communicate with passengers, dispatcher, other drivers, and emergency personnel.

- While driving a passenger (who relied on a respirator), his respirator stopped functioning, the respirator alarm went off and the passenger indicated distress by clicking his tongue. Had I not been able to hear the two warning signals this passenger would have died. The passenger is paralyzed and unable to indicate distress in any other method.

- One trip I heard a lady that was very upset. She was crying to I stopped the bus and the lady next to her threatened her with a gun. The woman was scared so she couldn't come up to the front of the bus but I heard her crying so I stopped the bus and solved the problem.

- Was driving outside of Hope I heard the front right brake shield guard was scraping against the front tire rim. I heart this problem and had to stop the bus as soon as possible to get the problem fixed.

- This is another example of a complete waste of time and tax payer's money...any idiot knows that to drive a bus safely...you must be able to hear. How trivial of you!

- As a bus driver in 1998 every trip has incidents or potential incidents! Every day I drive.

- Several small incidents during day-to-day driving. Hearing is critical to the job.

- Passenger falling out of seat because of a heart attack - stroke.

- Loose axle coming away from hub. Loose tire and rim on hub coming loose. Flat tire running on the inside of a dual set, unable to see through mirrors but can hear tire bouncing around before it separates and blows

- All types of emergency vehicles approach both from the front and rear coming off a side street out of sight of the operator. Can't see it but am able to hear before they came into sight.

- Hearing is very important to driving, in so many respects that it is pointless to try and list them all.

- A number of times a person has become separated from a child due to automatic closing of rear doors. Only a yell from the back has alerted me to this situation.

- I was exiting the highway on a blind exit ramp when I heard a loud bang. I thought I blew a tire but I wasn't sure. I slowed because I heard the noise and it was an accident in the middle of the curve. I may not have been able to stop if I didn't hear the noise.

- I dropped off all my passengers on a charter and drove away. A short time later I heard noise coming from the washroom. One of the passengers was banging on the wall because they were locked in the washroom and were quite distressed. The passenger was physically challenged and couldn't get out. I provided assistance but they may have been in there a while if I didn't hear them.

- I started to make a lane change on the highway when I heard a horn. I stopped the lane change and saw a car that I would have hit if I hadn't heard the horn.

- Someone caught in the back door, unable to see them, but could hear them.

- Escalating verbal conflict by passengers.

- Squealing tires, or honking horn, have warned of approaching problem.

- Continually detecting brake wear through noise - daily occurrence.

- In city driving emergency vehicles are constantly present.

- Passenger communication concerning on-board incidents are constant.

- Tire retread peeled off on Highway 99 and I heard pieces of it hitting in the wheel well.

- Vehicle passed bus as latter was turning. A second vehicle tried to cross traffic but because I heard the sound of the first vehicle approaching on the left side I was able to sound the horn and indicate to the second driver that he must immediately stop or face a side-on collision.

- I heard an emergency vehicle approaching and was able to stop a person who was deaf from stepping into its path. My ability to hear the emergency vehicle approaching combined with my higher vantage point gave me enough time to get out of the seat, off the bus, and alert the person.

- Female passenger had epileptic seizure and I heard her fall from her seat (she was out of view of my mirrors).

- Innumerable times in city traffic I hear emergency vehicles before I see them and it alerts you to be more aware for their safe passage.

- While backing a coach into an agency location, my guide whistled for me to stop when a person walked into the path of the area I was reversing into.

- With my drivers window partially opened I was able to hear tire noise of small vehicle in my blind spot to left that prevented me from changing lanes into it.

- While I was distracted answering questions from a passenger I was able to avoid an accident or confrontation with an ambulance whose presence alerted me with his siren

going.

- Train approaching 49 th Ave and West Blvd--No signals at intersection (out of order). I jumped out of bus to stop traffic. E and W bound 49. Heard train whistle before seeing engine. This line used once a week time approx. 15:30.

- Bus smoking in rear. Car driver sounded horn to stop when I opened window he informed me of fire in rear engine compartment. I was able to get assistance and put fire out. If I was unable to hear horn of passenger car a major incident would have occurred as flames were entering rear seat compartment on coach.

- Everyday city driving, emergency vehicles are heard before they are seen, allowing time to safety maneuver bus.

- Low air warning devices--the audio warning is usually the first indication the driver notices of serious problem.

- A passenger was having a heart attack on coach at back of coach and passengers were calling out to me (driver).

- Going on streets where emergency traffic is also travelling. Where are they and which way are they travelling.

- On the highway heard a thump, thump, on looking in my mirror saw a large lump on the left rear tire, seconds later had a blow out.

- Can hear emergency vehicles long before the rest of the other cars some to a stop.

- I heard a dual tire blow out and stopped coach right away.

- I heard a faint whimper in coach. When I investigated, a drunk was groping a "New Canadian" I kicked him (the drunk) off.

- If defrosters are on "high" its difficult to hear approaching sirens. I have delayed taking appropriate action for this reason.

- Approaching intersection I heard emergency sirens. I pulled to the side of road and looked for emergency vehicle. After about 5 seconds, the vehicle came into sight in intersection. I could not see the vehicle before this because of traffic congestion.

- Ability to hear emergency vehicles very important, as you usually hear them before you see them. Could have been hit many times in city traffic if I did not hear police cars, fire trucks, ambulances on way to their destinations. You hear these vehicles then you try to see which direction they are coming from as the noise rebounds off buildings, but if you didn't hear them first you wouldn't know they were approaching you unless you just happened to be looking the right way.

- Blowout I5 Highway, loaded with passengers and luggage. Heard it before I saw it enabled me to take positive reaction to get the bus safety pulled over out of traffic and stopped. The visuals and immediate feelings were not so different in the immediate handling of the bus but within a second or two there was major handling problems.

- Passenger distress is always heard by the driver either directly from the passenger or someone else informing the driver of a problem ie. to stop, or to inform the driver they are ill etc.

- Mechanical problems most often are first hearing (a pre warning) that something is not right. Visuals are usually second, or feelings ie. bangs, friction between objects, braking of metal parts inside coach such as seating, racks, door to washroom. Also buzzer signals are usually much more of a first indication over visual light signals being seen because of the "eyes on the road" part of driving.

Appendix M: CCMTA Memorandum of Understanding Respecting a Federal-Provincial-Territorial Agreement on the Adoption of a National Safety Code for Motor Carriers. Also included is a copy of the NAFTA Medical Requirements Respecting Deaf and Insulin Dependent Class 1,2, 3, and 4 Drivers.

Council of Ministers
Responsible for Transportation and Highway Safety

MEMORANDUM OF UNDERSTANDING RESPECTING
A FEDERAL-PROVINCIAL-TERRITORIAL AGREEMENT ON THE
ADOPTION OF A NATIONAL SAFETY CODE FOR MOTOR CARRIERS

THIS MEMORANDUM OF UNDERSTANDING

ENTERED INTO this 26 day of March, A.D. 1987 by and between

The Government of Canada herein represented by the Minister of Transport

and

The Government of Ontario herein represented by the Minister of Transportation and Communications

and

The Government of Québec herein represented by le Ministre des Transports

and

The Government of Nova Scotia herein represented by the Minister of Transportation

and

The Government of New Brunswick herein represented by the Minister of Transportation

and

The Government of British Columbia herein represented by the Minister of Transportation and Highways

and

The Government of Manitoba herein represented by the Minister of Highways and Transportation

and

The Government of Prince Edward Island herein represented by the Minister of Transportation and Public Works

and

The Government of Saskatchewan herein represented by the Minister of Highways and Transportation

and

The Government of Alberta herein represented by the Minister of Transportation

and

The Government of Newfoundland herein represented by the Minister of Transportation

and

The Government of Yukon herein represented by the Minister of Community and Transportation Services

and

The Government of the Northwest Territories herein represented by the Minister of Government Services

WHEREAS there is a concern that the regulatory reform of the motor carrier industry will require heightened attention to the safe operation of commercial vehicles; and

WHEREAS it is desirable to establish uniform standards governing the safe operation of commercial vehicles nationally and internationally; and

WHEREAS it is desirable that such heightened safety standards not be an impediment to the efficient and economic movement of goods and persons; and

WHEREAS it is desirable that such standards be effective, practical and enforceable; and

WHEREAS it is desirable that the federal, provincial and territorial governments recognize their shared responsibility for the safe operation of commercial vehicles; and

WHEREAS the Council of Ministers Responsible for Transportation and Highway Safety, meeting in Vancouver, British Columbia on October 3, 1985 agreed to the development of a national safety code for motor carriers; and

WHEREAS safety standards are an important instrument of public policy in promoting public safety; and

WHEREAS nothing in this Memorandum of Understanding should be interpreted as an intent to inhibit a province or territory from regulating the safe operation of commercial vehicles within a province or territory in a manner consistent with provincial or territorial policy;

THEREFORE, we the undersigned, do mutually agree:

1. to adopt, in principle, a national safety code for motor carriers;

2. to expedite the passage of necessary legislation;

3. to establish an equitable federal/provincial cost sharing formula;

4. to direct the CCMTA to proceed with further development of standards for a national safety code for motor carriers;

5. to develop an agreement, modelled on CAVR, which embraces the Code and the standards associated with it, and which identifies a structure and process for amending these over time.

SIGNED THIS 26 DAY OF March, 1987

GOVERNMENT OF CANADA

Minister of Transport

GOVERNMENT OF ONTARIO

Minister of Transportation and Communications

GOVERNMENT OF QUEBEC

le Ministre des Transports

le Ministre délégué aux Affaires
intergouvernementales canadiennes

GOVERNMENT OF NOVA SCOTIA

Minister of Transportation

GOVERNMENT OF NEW BRUNSWICK

Minister of Transportation

GOVERNMENT OF BRITISH COLUMBIA

Minister of Transportation and Highways

GOVERNMENT OF MANITOBA

Minister of Highways and Transportation

GOVERNMENT OF PRINCE EDWARD ISLAND

Minister of Transportation and Public Works

GOVERNMENT OF SASKATCHEWAN

Minister of Highways and Transportation

GOVERNMENT OF ALBERTA

Minister of Transportation

Approved as a Binding Intergovernmental Agreement
for the Government of Alberta

COMMERCIAL DRIVERS

CLASS 1, 2, 3, 4

Deaf and Insulin Dependent

At the present time, Canadian commercial operators who travel into the United States are required to hold an ICC Medical Certificate as well as their Canadian jurisdiction Driver's Licence. To reduce the costs and inconvenience to these commercial operators in meeting the US Federal Motor carrier Safety Regulations, a reciprocal agreement has been made with the United States for drivers holding Class 1, 2, 3, and 4 licences where they will no longer be required to submit to an ICC medical, provided that the driver meets the medical requirements and prescribed by their licensing jurisdictions. This agreement, which takes effect January 1, 1998, will enable Canadian commercial operators to travel into the United States without holding a second card and without the extra cost of a second medical examination. The reciprocal agreement does, however, have two exceptions in order to comply with United States federal law - insulin dependent diabetics and hearing impaired are not included in the reciprocity.

The United States Federal Motor Carrier Safety Regulations state the following:

> "Physical Qualifications and Examinations:
>
> 391.41(a) - A person shall not drive a motor vehicle unless he is physically qualified to do so and, except as provided in 391.67, has on his person the original, or a photographic copy, of a medical examiner's certificate that he is physically fit to drive a motor vehicle . . .
>
> (3) – Has no established medical history or clinical diagnosis of diabetes mellitus currently requiring insulin for control . . .
>
> (11) – First perceives a forced whispered voice in the better ear at not less than 5 feet with or without the use of a hearing aid or, if tested by use of an audiometric device, does not have an average hearing loss in the better ear greater than 40 decibels at 500 Hz, 1000 Hz, and 2000 Hz with or without a hearing aid when the audiometric device is calibrated to American National Standard (formally ASA Standard) Z24.5 - 1951"

These are the regulations governing commercial drivers in the United States and as such the agreement for the recognition of Canadian drivers must comply with the US regulations.

As part of the agreement, the United States requested that the Canadian jurisdictions remind applicable commercial drivers. There has been no change to the criteria drivers must meet to drive commercially in the US; operators of commercial vehicles have for many year and been required to carry an ICC medical card and drivers with the above noted medical issues would not have been able to successfully pass the standards of the ICC medical. In British Columbia, commercial drivers to whom this issue applies will be invited to have their licences reissued, without charge. The licence will be issued with an annotation stating that the commercial class of licence will not be accepted outside of Canada.

As the National Safety Code Standards apply only to drivers operating within Canada, the Standards are not applicable to the NAFTA agreement

Appendix N: Train Whistle Detection Project Executive Summary[33]:

Train Whistle Detection Project Scope and Procedures

As part of an assessment and review of its Medical Fitness Program, the Office of the Superintendent of Motor Vehicles (OSMV) of the B.C. Ministry of Transportation & Highways wishes to better understand the role of hearing in safe commercial driving - in particular the ability of truck drivers to detect a train whistle while inside the cab of a running tractor truck. ***Wakefield Acoustics Ltd.*** was retained to carry out a field study of the detectability of train whistle noise based largely on noise measurements made within the cabs of such trucks while parked at a variety of railway crossings. ***Wakefield Acoustics Ltd.*** was to hire and work with commercial vehicle operators with diesel tractor trucks capable of hauling super-B tandem trailers, proficiently measure the level and frequency of train whistles using standardized sound measurement equipment while at highway crossings in a variety of weather conditions, times of day, traffic conditions and geographic areas, and document the results in a clear and precise manner.

The bulk of the train whistle noise measurements were made along the CNR and CPR mainlines in Lower Mainland. Since regulations against train whistle blowing are currently in place in many of Greater Vancouver's more urban municipalities, these measurements were made in the more rural areas of north Langley, Pitt Meadows and Maple Ridge. On Wednesday, February 11, 1998, various CNR crossing sites were inspected and, with no tractor truck present, outside measurements were made of background noise and train whistle noise levels at track-side. Between 06:00 and 13:00 hours on February 12, train whistle noise measurements were made at the CNR crossings of Bradner Road, Lefeuvre Road, 272nd Street, 96th Avenue, and 104th Avenue (Port Kells) in Langley. Between 06:00 and 12:00 hours on February 13, whistle noise from CPR trains and the West Coast Express was measured at the Port Hammond, Albion and Maple Meadow Way crossings in Maple Ridge and Pitt Meadows. Limited measurements of whistle noise from the E&N Dayliner passenger train were made in Esquimalt near Victoria on the morning of February 19, 1998. ***A total of 40 train whistle noise events were captured at nine different railway crossings using three different tractor trucks.*** A number of other measurements were made of the background noise (without whistles) both in side and outside the truck cabs. The tractor trucks used were older (1986 to 1988), well maintained units so that engine noise levels inside the cabs were expected to have been moderate - i.e. not among the very loudest or quietest on the road.

All train whistle noise and background noise measurements were conducted using a Larson-Davis Model 2800 Real Time Analyzer, a portable sound spectrum analyzer capable of separating noise into its various frequency components (with selectable band-width) in real time. Most of the noise spectra were measured using the LD 2800's one-third octave band filters as these are used in most procedures for the calculation of perceived loudness and the detectability of signals in noise. In addition, some narrow band noise spectra were obtained (using a 200-line FFT analysis mode over a frequency range from 0 to 2500 Hz.) in order to reveal the frequency content of train whistle noise in much greater detail.

Train whistle noise measurements were made both inside the truck cabs with the microphone suspended near the driver's left ear position (see Photo No. 1) and outside at the crossing at a position about 1.8 m above the ground. During most in-cab measurements, the driver's window was open from 75 to 150 mm as is reportedly common practice for reasons of both audible warning detection and ventilation. To prevent window fogging, both no-draft windows were minimally "cracked" in all but a few cases. During all but a few in-cab measurements of train whistles, tractor truck engines were idling normally and radios were turned off. When an approaching train was first detected (usually audibly but sometimes visually), the LD 2800's Autostore mode was triggered manually and forty, one-third octave spectra were collected over a 10 second period. Generally a second, and sometimes a third, ten second data collection period was subsequently initiated before the train reached the crossing. Therefore, more than one whistle event was typically captured during each train pass-by.

[33] Conversations with Walter Hawrylenko, owner, operator of Saferway Driver Training School confirm that drivers "crack open" the door window vent or slightly open the main side window to keep the cab windows free from fogging. This is a common practice that may or may not be included in a trucking company's policy.

SUMMARY (cont'd)

Results and Conclusions

The conditions under which the various background noise and train whistle noise spectra were obtained are summarized in Tables 3.1, 3.2, 3.3 and 3.4, while the one-third octave band and 200-line, narrow band spectra obtained of train whistle and background noise at the railway crossings are presented in Figures 3.1 through 3.57.

Since the collection of train noise spectra inside the truck cabs was initiated manually upon the first, generally audible, detection of the whistles, it can be concluded that essentially all train noise whistle events which occurred concurrent with, or subsequent to, the initiation of data collection for each train pass-by, would have been detectable within the truck cabs with engines idling. Note that in Tables 3.1 through 3.4, all train whistle events are indicated as having been "Audible to Occupants" of the trucks. Since the human ear has the ability to detect pure tones in broad band noise of comparable, or even slightly higher, band levels, it is unlikely that a whistle noise event which was not detectable to the ear could be identified with confidence from the one-third octave band noise spectra recorded in the presence of the background noise.

It was felt that sound propagation conditions during the four days of train noise measurements were quite typical, in that there were no persistent winds and the cloud cover would have precluded air temperature inversions, both of which could, under some conditions, have enhanced the audibility of train whistles at large distances.

Railway regulations require that train whistles first be sounded 400 m from any level crossing and be continued (intermittently) until the crossing is reached. This requirement applies to all crossings, with or without gates, except where the use of whistles is prohibited by local municipal noise control regulations. It was generally observed that, for freight trains in particular, whistles were not sounded that far from the gated crossings. It is then conceivable that, whistles may be first blown at greater distances when trains are approaching ungated crossings. However, it has been judged, based on the measured noise levels of whistles blown at estimated distances of 250 to 350 m, that, in the absence of substantial noise shielding from landforms or large buildings, train whistles sounded at 400 m from a crossing should generally be detectable inside the cabs of idling tractor trucks (such as those used in this study) when a window, or windows, is open even slightly.

Since automotive window glass provides substantial "sound transmission loss" in the dominant frequency range of train whistle noise (350 to 2500 Hz.), train whistle audibility was expected to be significantly influenced by the conditions of the truck windows. This expectation was supported by the results of the only set of measurements made with all cab windows tightly closed (including no-draughts) and the truck engine shut off. While the initial train whistle (sounded 250 to 300 m from crossing) stood out quite clearly inside the cab of the shut down truck, the whistle noise levels were about 20 decibels (dB) lower than those observed in similar situations with the no-draught windows "cracked" open. As a result, if the truck engine had been idling normally, but all windows still tightly shut, the initial whistle sounding would not have been audible over the engine noise.

Truck radios were turned off during all but one train whistle measurement. In that single case the radio was played at a "moderate" level resulting in the overall noise level inside the cab of the 1988 Kenworth tractor being increased to 75 dBA from the 68.4 dBA measured with the radio off. With this somewhat elevated background noise level, train whistles sounded within 250 m of the crossings would still likely be audible with the no-draughts cracked and/or the driver's window open. However, if played at higher volumes, radio noise certainly has the potential to mask distant train whistles. Noise from traffic, industry or other sources may, in extreme cases (such as at very busy urban intersections or within noisy industrial facilities), have the potential to elevate noise levels inside truck cabs so as to contribute to the masking of train whistles. However, based on the outdoor noise levels measured in the present limited study, this would not appear to be a general concern.

Appendix O: National Safety Code Hearing Standards for Drivers

TABLE OF CONTENTS

MEDICAL STANDARDS FOR DRIVERS

INTRODUCTION

The medical standards, or guidelines, proposed in this document were developed by medical advisors and administrators from Canadian provincial driver licensing bodies. Many of the standards are adopted from the Canadian Medical Association's Guide for Physicians in Determining Fitness to Drive, fifth edition. Where this is the case, a notation will appear with reference to the appropriate section of the C.M.A. manual. [1]

The standards are intended as a guide in establishing basic minimum medical qualifications. They can be utilized by both physicians and administrators in assessing an individual's ability to operate a motor vehicle.

Licence classes indicated are based on the classes as defined in the CCMTA Classified Driver Licensing System.

A contributing factor to the success of these medical standards is the commitment to cyclical review. The standards will therefore be reviewed on an on-going basis and updated accordingly so they can remain current and reflective of existing medical opinion.

HEARING

2.1 Recommended Hearing Standards

The effect of impaired hearing on driving is difficult to define. However, most hearing-impaired drivers are conscious of their impairment and compensate by being more cautious and alert and by making more use of their mirrors than drivers with normal hearing. (C.M.A. 4.0)

In Classes 5 and 6, hearing loss should not constitute a barrier to driving ability. While the ability to hear or communicate is of paramount importance for the operator of a passenger bus, ambulance or other emergency vehicles (Classes 2 and 4), there are a number of factors which suggest it is inappropriate to apply that same requirement to the operator of a Class 1 or 3 motor vehicle. For example, high inside noise levels in truck cabs militate against hearing standards and may induce further hearing loss should an individual be compelled to use a hearing aid to meet the standard. In addition, in recognition of the prevalence of hearing loss among holders of Class 1 and 3 licences, manufacturers are now producing virtually soundproof cabs which eliminate outside noise thereby rendering hearing standards irrelevant.

Consequently, it is suggested that the holder of a Class 2 or 4 driver licence and the operators of emergency vehicles be required not to have a hearing loss greater than 40 decibels averaged at 500, 1000 and 2000 Hertz. Should the individual require the use of a hearing aid to attain the standard the licence issued should bear a notation such as "valid for Class # only when wearing a hearing aid". While it is agreed that a degree of hearing would be beneficial for all motor vehicle operators, in the absence of empirical data the totally deaf individual who is able to successfully complete the driving tests should be permitted to obtain or hold a Class 1, 3, 5 or 6 driver licence.

It is recommended that the applicant or holder of a Class 2 or 4 licence whose degree of hearing loss is at question be requested to file a report of an audiometric assessment.

It is also recommended that individuals who hold a Class 1, 3 or 5 licence and are engaged in the transportation of dangerous goods meet the medical requirements corresponding to Classes 2 and 4 as stated above.

Operators of emergency vehicles should also meet the hearing standards established for Classes 2 and 4. A special endorsement could be established in order to deal with emergency vehicle operators and transporters of dangerous goods.

STANDARD: NO HEARING STANDARD FOR CLASSES 1, 3, 5 AND 6 WITH THE EXCEPTION OF TRANSPORTERS OF DANGEROUS GOODS.

HEARING LOSS NO GREATER THAN 40 DECIBELS AVERAGED AT 500, 1000 AND 2000 Hz APPLIES TO CLASS 2 AND 4 LICENCES, OPERATORS OF EMERGENCY VEHICLES AND TRANSPORTERS OF DANGEROUS GOODS.

Appendix P: Comments from a Member of the Deaf Community

Views from the Deaf Community

- The involvement of medical doctors in the formulation of government policies that affect deaf and hard of hearing persons is unwarranted and unnecessary. Such doctors are experts in physical problems and in rectifying them, but they have no expertise in how deaf and hard of hearing persons function with their deafness in their daily lives. Doctors also have no expertise in driving issues *vis a vis* the sense of hearing, having made their recommendations without ever sitting in the cab of a truck.

- Audiograms are one-dimensional and an highly unreliable, if not inaccurate, means of determining the deaf or hard of hearing person's ability to drive safely or to function in general. Two persons can have an identical audiogram but have completely different responses to their deafness: a late-deafened adult and a deaf person who has been deaf since birth. To the late-deafened person, deafness can be a disabling condition which can impair their ability to function normally while the congenitially deafened person does not feel impaired by his deafness, having developed unique coping strategies that compensate for his deafness.

- The hearing function is not an absolute requirement for safe driving, and many deaf persons are just as capable as any other person of driving any type of vehicle. In addition, it has been generally agreed that vision is much more crucial for safe driving than hearing. Deaf persons who have been deaf since infancy or childhood tend to be more visually alert and tactile-sensitive than those persons with normal hearing, which, in theory, would make them better drivers than hearing drivers. Deaf drivers can focus better on the road traffic without any auditory distractions such as radios, cassette/CD players, walkmans, citizen's band radios and cellular phones. In fact, because of the high noise levels in large trucks, vision and tactile sensation take on a more crucial role.

- Restrictions on deaf drivers were arbitrarily formulated and imposed without any basis in scientific fact and are discriminatory in nature. Under normal circumstances, restrictions and limitations tend to be put into place in reaction to accidents or dangerous situations that have occured. To our knowledge, such situations that occured because of deafness have been exceedingly rare. The typical reaction towards a traffic accident caused by a deaf driver tends towards sweeping generalizations: deaf drivers are dangerous and should be banned from driving, never mind the fact that the cause of accident was not deafness itself. Such assumptions about deaf drivers are rooted in audism which is the belief that persons with normal hearing and speech are superior to those persons who either lack them or are impaired in these functions. Audism, "like racism or sexism which judges, labels, and limits individuals on the basis of race or gender, results in a negative stigma towards individuals who do not hear auditory stimuli" according to Dr. Jan Humphey of Douglas College. It is the basis for much of the discrimination suffered by deaf and hard of hearing persons at the hands of persons with normal hearing who hold all the power.

- Much of the research evidence on deaf drivers versus hearing drivers is unreliable and in no way establishes deafness *per se* as proof of unsafe driving on the part of deaf drivers as there are too many variables such as educational background, access to information, cultural upbringing, and communication styles. Qualitative research evidence based on opinions about deaf drivers by professional drivers with normal hearing is highly questionable and largely audist in nature because they have no experience with deafness and cannot conceive of any other driving situation except with normal hearing.

- There is a question of whether restrictions on deaf commercial drivers should be determined by employers or employer associations rather than the Motor Vehicles Branch, based on the actual job requirements (e.g. ability to communicate by speech with others, to use citizens' band radio, and so on). We need to examine the various driving functions and determine which ones for which the sense of hearing is absolutely essential and should be regulated by MVB. In addition, technology exists in which visual alerting devices can substitute largely for the hearing function.

- We must not lose sight of the fact that the VAST majority of vehicular accidents are caused by drivers with normal hearing. To impose restrictions on deaf drivers while allowing other drivers with different but potentially dangerous physical problems such as sleep apnea (a condition which is more prevalent than deafness) to drive is discriminatory. Likewise, if MVB considers the ability to communicate with passengers essential for safe driving, should it so follow that there should be new restrictions imposed on those mute or speech-impaired persons with normal hearing? Does MVB have restrictions on drivers who have demonstrated emotional instability which can lead to incidents of road rage? If MVB is sincerely concerned about the safety of passengers and road safety *vis a vis* physical/mental fitness, then it should clearly identify more classes of functionally impaired persons subject to restrictions such as persons with mental disorders, persons with a history of alcohol/drug addiction, and so on. Not to do so will reinforce the view that restrictions on deaf and hard of hearing drivers are based on audism and support the case for the discrimination complaint against the MVB by such individuals. Because the numbers of deaf persons are so small in comparison to other groups with different functional impairments, it is easier to impose restrictions on the deaf. Since the deaf lack the political clout, it is all the more reason for the Human Rights Commission to step into the picture on their behalf.

Appendix Q: OSMV Response to the Deaf Community Member's Comments

The following comments are in the order of the comments in Appendix P:

- Physicians, particularly Otolaryngologists, who have an interest in deafness do have expertise regarding the activities of daily living of deaf people. Otolaryngologists who also have an interest in fitness to drive are chosen to establish medical criteria for fitness to drive. In the absence of empirical research regarding the risk of deafness and driving, the consensus of medical opinion is relied upon to establish BC, national and international guidelines. It is probable that groups of specialists established the medical criteria for fitness to drive for diabetes, seizure disorders, disorders of vision, etc without having those conditions themselves and without sitting in the cab of a truck.

- Audiograms are reliable in assessing hearing loss with pure tones. Reliable means that different audiologists would have similar results on the same patient. Pure tone audiograms do not predict speech detection and comprehension, or the ability to lip-read. Hearing is unrelated to driving skills *per se*. However, the OSMV believes that current restrictions are justifiable in order to protect public safety, because the role of commercial drivers encompasses a great deal more than driving skills. Whether deafness is congenital or late onset does not affect the ability of commercial drivers to detect train whistles at uncontrolled railway crossings, the ability to communicate with passengers, or emergency vehicle personnel in passenger for compensation vehicles.

- As in the above paragraph, the statements are unsubstantiated.

- It is agreed that there is no satisfactory research which determines the relative risk of accidents for deaf commercial vehicle drivers. However, the OSMV believes that "discrimination" regarding deaf drivers, with respect to vehicles with passengers for compensation and transportation of dangerous goods is justifiable. Furthermore, in accordance with the consensus of medical opinion and guidelines set out by other jurisdictions it is reasonable. The fact that "audism" occurs in society does not permit the OSMV to ignore the consensus of medical opinion and other jurisdictions, nor does it permit an experiment (ie., no restrictions for deaf drivers), as a result of which preventable loss of life, medical impairments and human suffering may be the outcome. Additionally, it is considered unethical to proceed with an experiment to which the public has not given informed consent.

- It is agreed that existing research is less than optimal. Although OSMV does not rely on the opinions of professional commercial drivers to establish policy, comments about job description and anecdotes in which hearing was the only way problems were detected cannot be dismissed.

- The OSMV has the legislated mandate to protect public safety. This responsibility may not be delegated to employers by the OSMV. Employers expect that licensed drivers are fit to drive and meet the required medical criteria. This Committee did examine which professional driving functions require hearing (see Appendices B, J, K, L, N, and R). There is no evidence that audio detection technology has been proven safe and effective. No jurisdiction has accepted such technology as a replacement for hearing.

In particular, the OSMV has not received any submissions from the Deaf Community or any other source that would persuade this office that any change in policy regarding dangerous goods, emergency vehicles or passenger for compensation vehicles is prudent at this time.

- OSMV is and has always been very concerned about drivers with any kind of impairment. Any drivers documented to have sleep apnea, mental disorders, alcohol/drug problems, and numerous other medical problems[34] , which physicians consulted believe to be hazardous, are restricted from driving not only commercial vehicles, but also passenger vehicles. Anyone deemed to be at risk by their physician or who is known to be at risk by the OSMV is required to have a Driver's Medical Examination and, in some cases, a road test prior to consideration of an application to receive or renew a licence.

Prepared by:
Ed Domovitch MD
May 28, 1998

[34] See the BC *Guide for Physicians in Determining Fitness to Drive a Motor Vehicle*.

Appendix R: European Directive Model for Driver Licensing, Training Truck Drivers, Road Transport Research, Organisation for Economic Co-operation and Development, Paris, 1996.

The 1991 European Union Directive on Driver's Licensing covers the principal requirements. The elements addressed in the Directive are representative of other countries' and continents' evaluation elements.

General

The truck driver must be able to:

- Recognise traffic dangers and assess their seriousness;
- Have sufficient command of his vehicle not to create dangerous situations and to react appropriately when dangerous situations occur;
- Comply with road traffic regulations;
- Detect any major faults in his vehicle and have then corrected in an appropriate fashion;
- Take account of all the factors affecting driver behaviour, e.g., alcohol, fatigue, poor eyesight, etc., so as to retain full use of his facilities;
- Help ensure the safety of all road users.

Driver skills

Drivers must be able to:

- Check the conditions of the tires, lights, reflectors, steering, brakes, direction indicators and audible warning device;
- Adjust the seat as necessary;
- Adjust the rear-view mirrors and seat belts;
- Check that the doors are closed.

Drivers must be able to use the vehicle controls, namely:

- Steering wheel;
- Accelerator;
- Clutch;
- Gears;
- Handbrake and footbrake.

Drivers must be able to:

- Start the engine and move the vehicle smoothly;
- Accelerate to a suitable speed while maintaining a straight course, including during gear changes.

Knowledge

Truck drivers must be able to demonstrate their knowledge and understanding in the following fields:

- Importance of alertness and attitudes to other road users;
- Mechanical aspects of their vehicle;
- Principles concerning the observance of safe distances between vehicles and braking distances under various weather and road conditions;
- Perception, judgement and decision-making, especially reaction times, as well as changes in driving behaviour de to the influence of alcohol, drugs and medical products;
- Specific risk factors related to the lack of experience of other road users;
- Risks involved in the driving of various types of vehicles and the different fields of view for the drivers of these vehicles;
- Driving risk factors related to various road conditions;
- Characteristics of various types of roads;
- Vehicle safety equipment and in particular the use of seat belts;
- Rules regarding the use of a vehicle in relation to the environment;
- Road safety regulations and in particular road signs including markings;
- Rules concerning the administrative documents required for the operation of the vehicle;
- General rules specifying the behaviour of the driver in the case of an accident;
- Safety factors relating to the vehicle and the persons on-board;
- Adjust speed to negotiate left or right turns at junctions while maintaining control of the vehicle;
- Reverse in a straight line and reverse right or left around a corner while keeping within the correct traffic lane;
- Turn the vehicle to face the opposite direction using forward and reverse gears;
- Brake accurately to a full stop and if needed by performing an emergency stop;
- Park a vehicle and leave a parking place both in forward and reverse gears' on a flat, downhill and uphill surface.

Driver behaviour

Drivers must be able to perform all the usual manoeuvres in complete safety in normal traffic situations:

- Observe road alignment, markings, signs and potential or actual risks;
- Communicate with other road users;
- React appropriately in actual risk situations;
- Comply with road traffic regulations and the instructions of the police;
- Show due respect for other road users.

Drivers must also have the following skills in traffic situations:

- Move from the kerb and/or from a parking place;
- Drive a vehicle correctly positioned on the road, adjusting speed to traffic conditions;
- Keep the right lane distances between vehicles;
- Change lanes;
- Pass parked or stationary vehicles and obstacles;
- Meet on-coming vehicles, including in confined spaces;
- Overtake in various situations;
- Approach and cross level crossings;
- Approach and cross junctions;
- Turn right and left at junctions or the leave the carriageway.

Rules specific to heavy freight vehicle drivers

Truck drivers must also demonstrate knowledge and sound understanding in the following areas:

- The effect of wind on the course of the vehicle;
- Rules on vehicle weights and dimensions;
- Rules on driving hours, rest periods and use of on-board monitoring devices;
- Principles of braking systems and speed governors;
- Precautions to be taken regarding splash and spray when overtaking other vehicles;
- Reading a road map;
- Know the safety factors related to vehicle loading.

Truck drivers must also be capable of:

- Checking the power-assisted braking and steering system;
- Using the various braking systems;
- Using speed reduction systems other than the brakes;
- Adjusting the course of the vehicle when turning to allow for the length of the vehicle and its overhang;
- Coupling and uncoupling the trailer and semi-trailer to and from the tractor.

Appendix S: Relationship of hearing loss to the loudness of familiar sounds (dB)

DECIBEL (dB) LEVEL	FAMILIAR SOUNDS	HEARING LOSS
0	Technical threshold reference level.	Normal
10	Breathing (practical threshold).	Normal
20	Faint whisper. Quiet room.	Normal (up to 25 dB)
30	Average whisper. Rural area.	Mild (26 dB to 39 dB)
40	Soft speech at 3 feet. Quiet office.	Mild
50	Average office. Quiet street.	Moderate
60	Average speech. Typewriter. Vacuum cleaner.	Moderately Severe (55 to 70 dB)
70	Moderately loud speech. Automobile engine.	Severe
80	Heavy traffic. Loud speech. Noisy factory.	Severe
90	Elevated train. Jack hammer at 10 feet.	Severe
100	Subway train. Symphony orchestra playing fortissimo (very loud). Chain saw.	Profound
110	Thunder. Air plane piston engine. Loud shout at one foot.	Profound
120	Air plane jet engine.	Profound
140	Large air-raid siren at one foot. Shotgun blast. Pain-producing noise.	Profound

Appendix T: Additional MVA Regulations related to the Hearing Issue

Motor Vehicle Act Regulations section 37.22

(1) No carrier shall permit a driver to drive, and no driver shall drive, a commercial vehicle unless the requirements of this section are met.

(2) The driver or a person specified by the carrier shall satisfy himself or herself that the commercial motor vehicle is in a safe operating condition including, but not limited to, the operating condition of the following items:

(a) service brakes, including trailer brake connections and brake adjustments;
(b) parking brakes;
(c) steering mechanisms;
(d) lighting devices and reflectors;
(e) tires;
(f) horn;
(g) windshield wipers;
(h) rear vision mirrors;
(i) coupling devices;
(j) wheels and rims;
(k) emergency equipment;
(l) load securement devices.

(3) The inspection referred to in subsection (2) shall be performed daily before the first trip of the day.

(4) If a trip lasts more than one day, the inspection required by subsection (2) shall be carried out on the second and every subsequent day of the trip no later than the first rest stop of the day.

(5) If a commercial motor vehicle's first trip of the day is to provide relief from earthquake, flood, fire, famine, drought, epidemic, pestilence or other disaster by transporting passengers or goods, the inspection required by subsection (2) shall be carried out before the commercial vehicle's first trip that is not for that purpose.

(6) The driver or the person specified under subsection (2) shall,

(a) at the end of the final trip of the day, or
(b) where a trip lasts more than one day, on every subsequent day of the trip at the final rest stop of the day, inspect the commercial motor vehicle and record in the trip inspection report defects as observed as a result of this inspection or while in charge of the commercial motor vehicle.

Motor Vehicle Act Regulations section 7.02 (1)

Subject to section (2 - Sirens and Theft Alarms), every motor vehicle shall be equipped with a horn which will emit sound audible under normal conditions from a distance of 60 m, but no horn shall emit an unreasonably loud or harsh sound or a whistle.

Appendix U: The Grismer Decisions

The 1994 Human Rights Tribunal Decisions are Summarized below:

The Office of the Superintendent of Motor Vehicles had not demonstrated that visual standards are necessary, i.e., limited empirical evidence.

There is a weak link causal link between poor vision and risk of accident, thus the Branch has a possibility and responsibility to individually assess driving skills.

The Office of the Superintendent of Motor Vehicles has discriminated on the basis of physical disability, and is to refrain from committing the same or a similar contravention.

The 1997 Court of Appeal for British Columbia Decisions are as follows:

The Superintendent was entitled to have the *bona fide* and reasonable justification defense fully considered.

The consensus of medical opinion justifies the causal link between the loss of left side peripheral vision and accident risk.

In this case, an individual assessment was not reasonable or practical. As there is no safe or reliable form of testing that deals with unexpected or exceptional traffic conditions.

Impact of Court of Appeal Decision on the Medical Review Program

Empirical evidence is not always necessary to justify a medical standard.

The use of consensus of medical opinion is sufficient to justify a medical standard.

The Superintendent is not required to individually assess a driver who fails to meet a medical standard.

It is unreasonable to demand an individual assessment when an individual assessment is not practical.

Appendix V Miyazaki, S. and Ishida, A, "Traffic-alarm sound monitor for aurally handicapped drivers", *Medical & Biological Engineering & Computing*, Vol. 25, pp. 68 - 74, January 1987.

Traffic-alarm sound monitor for aurally handicapped drivers

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Abstract—*There are several countries in the world in which people with severe hearing loss are not eligible for a car driver's licence. As a technical approach to solve this problem, an electronic device has been developed which detects traffic-alarm sounds, i.e. horns of cars, sirens of emergency vehicles, and alarm signals of railway crossings, and then displays them as a light signal to the driver. The basic operating principle of the device is that those traffic-alarm sounds have sharp line spectra in the frequency domain whereas ambient traffic noise is wide-band random noise. The real time detection of the line spectra, masked by random noise, is realised by use of a phase-locked loop and a simplified lock-in amplifier. The results of simulation experiments and road tests demonstrate that the performance of the device is satisfactory except in the case of the detection of the alarm signal of a railway crossing.*

Keywords—*Aurally handicapped, Alarm monitor, Driving, Electronic aid*

Med. & Biol. Eng. & Comput., 1987, 25, 68–74

1 Introduction

THE AUTOMOBILE is one of the most convenient methods of transportation in modern countries and is sometimes a necessity for daily living. In several countries, however, people with severe hearing loss are not eligible for a driver's licence. For example, in Japan the traffic law states that those who cannot detect the sound of a horn of 90 dBA, with a hearing aid, are ineligible for a licence for any type of automobile. It is roughly estimated that there are between ten and fifteen thousand aurally-handicapped people in Japan who do not pass this criterion and still have a potential need to drive. Sweden and Hong Kong have similar regulations.

Solid scientific background data for such regulations is lacking and thus there may be good reason for the deaf associations' movement for a qualification-free licence. However, the attitudes of administrative agencies is, in general, unfavourable and poor road conditions must be taken into consideration, particularly in Japan.

One possible technical solution to this problem is to develop a device which reliably detects and displays only traffic-alarm sounds, i.e. horns of cars, sirens of emergency vehicles, and alarm signals of railway crossings, amongst a background of traffic noise. A siren monitor developed by Thompson Technical Research (1980) is one such example. A drawback of this device is that it detects only the sirens of emergency vehicles and it is not fool-proof. Another electronic device was developed by the Ministry of Welfare of Japan (1976). The major weakness of this latter device is that it cannot detect electrical sirens and there are instances where it does not detect horns, those of short duration in particular.

First received 29th December 1984 and in final form 9th April 1986

In view of these problems, the authors have developed a new electronic alarm monitor. The major technical difficulty is that the alarm sounds are usually masked by ambient traffic noise. If a special radio frequency signal were to be emitted synchronously with the alarm sound, it would be much easier to detect it. This, however, would require modification of all existing and new cars and is evidently unacceptable socially and economically. The next problem is that the alarm sound must be detected in real time. Cost is another important factor; the device must be within a reasonable price range, roughly one-tenth of a new car.

In this paper, basic operating principles and outline of the device are described in Section 2; results of the performance tests are given in Section 3. For technical details of the device, readers may refer to a separate paper (MIYAZAKI and ISHIDA, 1984).

This device will hopefully benefit aurally-handicapped drivers in other countries where the driver's licence is qualification-free. It is expected that the device will relieve them of unnecessary mental stress during driving.

2 Outline of the device

2.1 *Nature of traffic-alarm sounds and ambient traffic noise*

The device utilises acoustic characteristics of traffic alarm sounds and differentiates them from the ambient traffic noise. Fig. 1 shows examples of sound spectrograms of different traffic-alarm sounds and ambient traffic noise.

As different alarm sounds have different tones, they present quite different shapes in the sound spectrogram. This is true even in the same category of alarm sound, e.g. horns of passenger cars. Only typical examples are given in Fig. 1. The most important feature of these alarm sounds

as compared with the ambient traffic noise is that they, without exception, present sharp line spectra in some frequency range while the traffic noise shows a relatively blunt envelope. If expressed in the time domain, this means that alarm sounds contain components which have marked regularity whereas the traffic noise is a wide-band random noise.

Fig. 1 was analysed to determine the nature of the different sounds. The electric horn, which is used in most passenger cars and small to middle size buses and trucks, has a basic resonant frequency in the 300–500 Hz frequency range (Fig. 1*a*), which will be referred to below as the low frequency range. There are many line spectra representing higher harmonics and dominant harmonics exist in the 2–4 kHz range (high frequency range). The air horn, which is used in large buses and heavy duty trucks and trailers, has dominant line spectra in the low frequency range (Fig. 1*b*). All air horns in new Japanese-made heavy buses and trucks are used in a double horn mode; two air horns with slightly different resonant frequencies are used in parallel. The two peaks seen in the low frequency range in Fig. 1*b* represent these different basic resonant frequencies. Although very small in number, some old buses and trucks are equipped with a single air horn, in which case only one

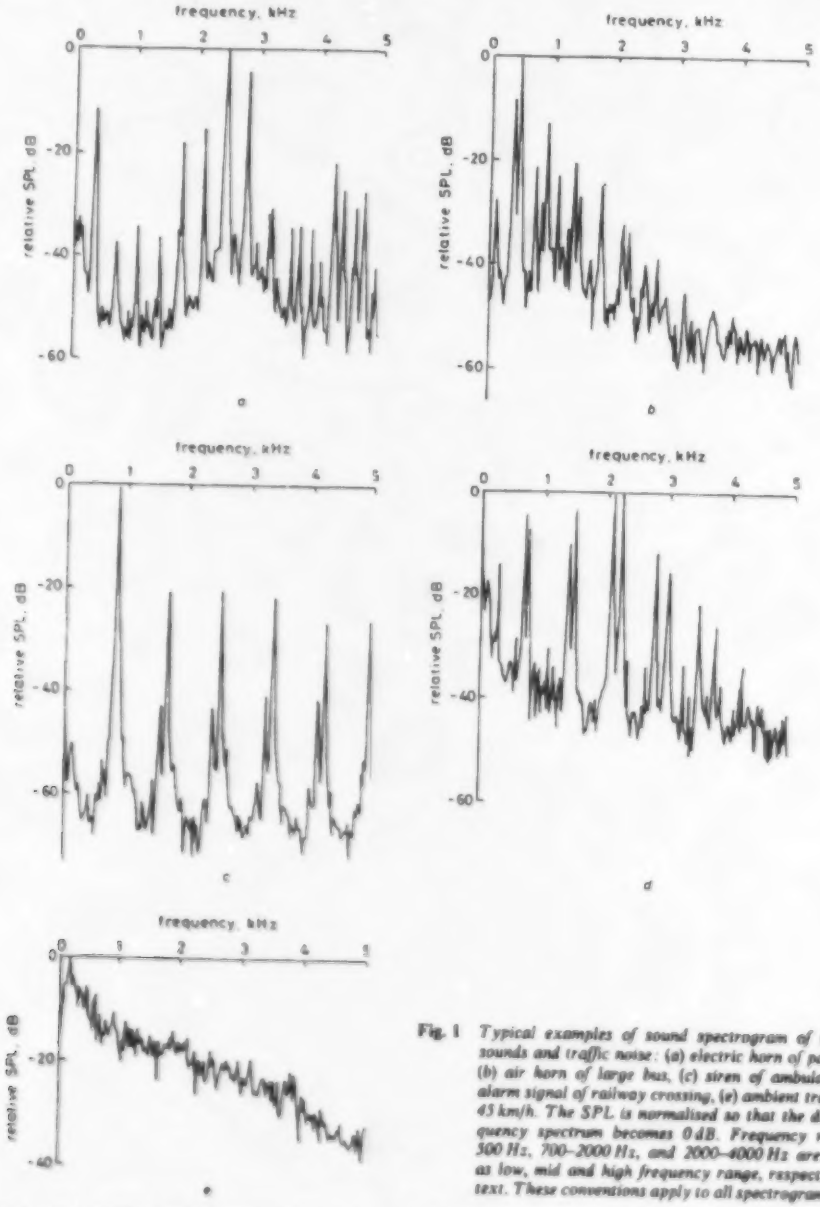

Fig. 1 Typical examples of sound spectrogram of traffic-alarm sounds and traffic noise: (a) electric horn of passenger car, (b) air horn of large bus, (c) siren of ambulance car, (d) alarm signal of railway crossing, (e) ambient traffic noise at 45 km/h. The SPL is normalised so that the dominant frequency spectrum becomes 0 dB. Frequency ranges 300–500 Hz, 700–2000 Hz, and 2000–4000 Hz are referred to as low, mid and high frequency range, respectively, in the text. These conventions apply to all spectrograms

peak appears in the low frequency range. The higher harmonics of the air horns are, in general, weaker than the basic resonant frequencies. The siren of emergency cars has a very simple spectrogram structure (Fig. 1c). The single basic frequency is dominant and lies between 700 and 2000 Hz (mid frequency range) and weak higher harmonics exist in the mid and high frequency ranges. The spectrogram of the warning signal of Japanese railway crossings is comparatively complex as shown in Fig. 1*d*. Usually one to three dominant line spectra are seen in the mid frequency range and sometimes in the high frequency range.

The ambient traffic noise (Fig. 1*e*) has dominant components below 300 Hz and this component represents running engine noise. The spectrogram gradually decreases at higher frequencies. This random contour represents the noise generated by the wind flow along the car body (wind noise) and the noise generated by the friction between the tyres and the road surfaces (friction noise).

circuit is interposed between the BPF and the line spectrum detector. In the case of double horns, the two resonant frequencies exist in the low frequency range and beat at a frequency equal to the difference between the two resonant frequencies. This beat frequency falls in the range 50 to 110 Hz. In the beat detection circuit, the low frequency signal is full-wave rectified and then bandpass filtered. Thus, a quasi-sine wave corresponding to the beat is extracted. The centre frequency of the PLL of the line spectrum detector following the beat detector is tuned to 65 and 95 Hz in channels 1A and 1B, respectively.

The basic function of the logic block is to convert the analogue outputs of the line spectrum detection circuit into logical signals by way of the thresholds and then take logical OR of the logic signals. This simple logic, however, causes many false-alarms. Thus, an error-suppress circuit is incorporated into the logic block as described in more detail in Section 2.4.

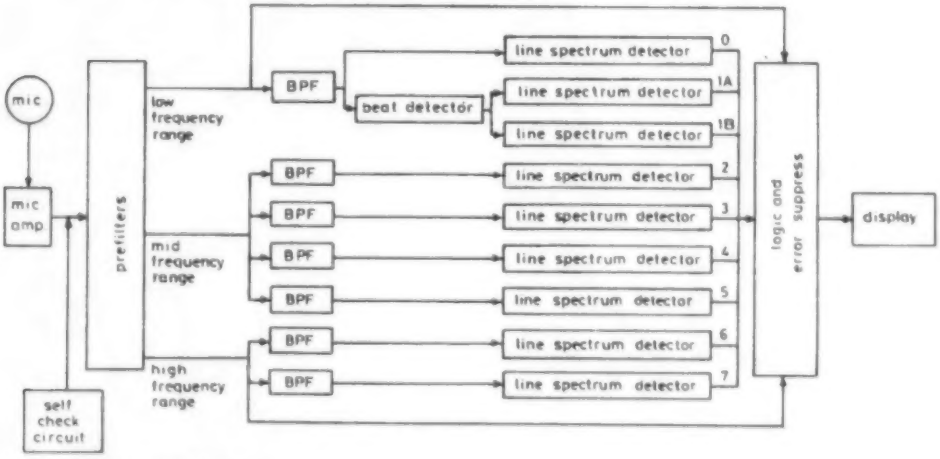

Fig. 2 *Block diagram of the device*

2.2 *Block diagram of the device*

Fig. 2 shows the block diagram of the device. An omnidirectional condensor microphone measuring 9 mm (diameter) by 8 mm (Hoshiden Electric Co., Ltd., KUC-1523, sensitivity −65 dB) is used to pick up the sounds. The microphone is placed on the upper edge of the rear window so that the effect of engine noise, wind noise and friction noise are minimised and thus the best signal-to-noise (S/N) ratio is achieved. The microphone is covered by a plastic hood of hemiconical shape for protection against rain. The voltage generated by the microphone is amplified by a microphone amplifier the gain of which is 34 dB. An automatic level control (ALC) function is incorporated into this amplifier in order to prevent the saturation of the output due to an excessive input. Prefilters divide the output of the microphone amplifier into three voltage signals, representing the low, mid and high frequency ranges. These signals are fed into a bandpass filter (BPF) which is followed by a line spectrum detection circuit. There are seven such channels: 0, 2, 3, 4, 5, 6 and 7. The centre frequency of the BPF and the phase-locked loop (PLL) of the line spectrum detector of these channels is tuned to 0·40, 0·73, 0·99, 1·34, 1·81, 2·45 and 3·31 kHz, respectively.

Channels 1A and 1B are specially designed to detect sounds of double horns. In these channels, a beat detection

The logic circuit drives a display circuit. As a display, a high-brightness light emitting diode (Stanley Electric Co. Ltd., H500, brightness 500 mCd) is used. The LED is attached to the frame of a pair of spectacles so that the red light is directed into the peripheral region of vision. Finally, because the reliability of the device is directly related to the safety of the driver, a self check circuit is incorporated in the device.

2.3 *Principle of the line spectrum detector*

Fig. 3 shows schematically the organisation of the line spectrum detection circuit. The voltage signal representing the low, mid or high frequency range is first bandpass filtered to narrow the frequency range of each respective channel. The output of the BPF (*a*) is fed into a PLL. By

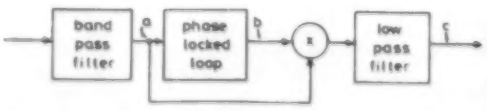

Fig. 3 *Organisation of the line spectrum detection circuit. Signal a is the output of BPF and signal b is the output of PLL. These signals are multiplied by an analogue multiplier*

appropriately adjusting the value of the loop filter constant of the PLL, it is possible to make the PLL track only the signal of traffic-alarm sounds and not track the ambient noise. This is clearly seen in two sets of traces in Fig. 4. Here, the upper set shows the output of the BPF and the output of the PLL of the 7th channel in response to the electrical horn which is shown in Fig. 1*a*. The output of the BPF (*a*) is always in phase with the output of the PLL (*b*). These two signals are multiplied by the multiplier shown in Fig. 3. As the two signals are in phase, the output of the multiplier is always positive.

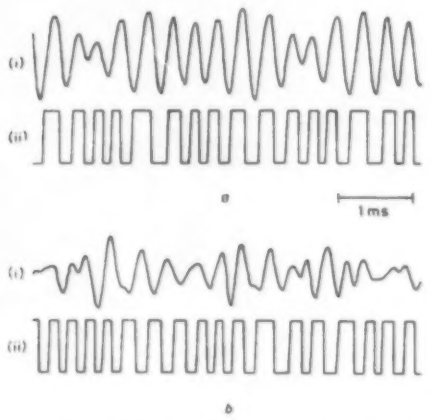

Fig. 4 *Tracking performance of PLL: (a) electric horn, (b) traffic noise: (i) output of BPF (signal a in Fig. 3), (ii) output of PLL (signal b in Fig. 3)*

When the input of the line spectrum detection circuit is random noise, the PLL cannot always track input signal *a*. Therefore, signal *a* and signal *b* are out of phase in some portions and in phase in some other portions as shown in the lower set of traces in Fig. 4. When these signals are multiplied, the output is sometimes negative and sometimes positive. The function of the low pass filter (LPF) following the multiplier is to average these positives and negatives in the time domain to yield a relatively low positive output. If no LPF is used, an erroneous high positive output of short duration would be accidentally generated by the multiplier and this would be misinterpreted as the alarm sound. A typical example of the output of the line spectrum detection circuit of the 6th channel is shown in Fig. 5. The sound pressure level (SPL) of the background traffic noise is 70 to 101 dB during this session. Large, middle and small horns are heard, and the analogue output exceeds the threshold.

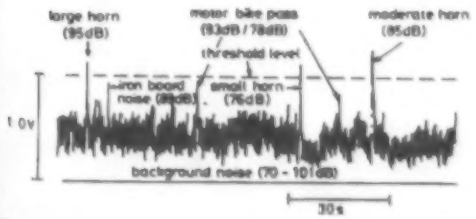

Fig. 5 *Example of the analogue output of the line spectrum detection circuit of the 6th channel*

This algorithm of line spectrum detection was originally devised by the research group formed by the Ministry of Welfare of Japan (1976), but the arrangement of channels, the hardware implementation of the algorithm and the addition of the beat detector are our own design.

2.4 *Error suppress circuit*

As explained above, the present device detects the traffic-alarm sounds on the basis of the presence of the line spectra. Therefore, those sound sources other than the traffic-alarm sounds which have marked line spectra are also detected. They include the squeaking noise of brake and tyre, engine noise at very high revolutions, wind noise at high speed driving, the human voice and music. To decrease the occurrence of false alarms due to these sources, an error suppress algorithm was invented. The basic idea is that the SPL of horns changes quite rapidly while the SPL of the above sound sources usually varies relatively slowly. For example, the time constant of the change of the SPL of horns is in the order of 10 ms whereas that of the engine revolution at starting is of the order of from 100 ms to several seconds. To discriminate between them, the following electronic circuits were used. First, the voltage signals of the low and high frequency ranges are amplified at appropriate gain, and then half-wave rectified to extract envelopes. Envelopes are then differentiated by HPFs, and outputs are compared with threshold voltages to yield logic signals. By taking the logic AND of these logic signals and the logic outputs of the line spectrum detectors of corresponding frequency range, an alarm output is obtained only in the case where the rise of the SPL of the input sound is rapid and line spectra exist. For details, see MIYAZAKI and ISHIDA (1984).

This algorithm cannot be applied to the error suppression in the mid frequency range. The reason is that the mid frequency range is used primarily for the detection of sirens and alarm signals of railway crossings, and the change of the SPL of these alarm sound is slow. Fortunately, the frequency spectrum components of the above sound sources causing false alarms are relatively weak in the mid frequency range, and thus the chance of false alarms originating in this frequency range is very small.

In this way, the final decision logic output is obtained. When the duration of the alarm sound is short and thus the width of the decision output pulse is shorter than 0·5 s, the pulse is expanded to 0·5 s so that the driver does not miss the warning light.

3 Performance of the device

3.1 *Dimensions, current consumption and cost*

The device consists of 40 analogue ICs and 14 digital ICs, assembled on three printed circuit boards each measuring 200 × 115 mm, and contained in a case measuring 140 × 250 × 70 mm. Nine LEDs are mounted on the front panel. Each LED is used to check that the corresponding channel is functioning correctly. The power of the device is supplied from the 12 V car battery and the current consumption is 170 to 220 mA. The component cost of the device including the microphone, ICs, LEDs, and case is approximately 200 US dollars.

The present device uses commercially available ICs and is rated for operation between 0 and 70°C. If the device is to be used at lower temperatures, some ICs must be replaced by their industrial versions. The cost of the device would then be roughly doubled.

3.2 *Detection power simulation experiment*

To evaluate the power of the device to detect traffic-alarm sounds, it is necessary to measure the maximum distance at which the alarm sound can be detected under various conditions of background traffic noise. However, even if the evaluation is to be limited to the case of horns, the SPL and tone of the horn varies greatly with each car, and it is very difficult to conduct an adequate evaluation in actual road tests. Further, it is practically impossible to make precise road experiments in the case of sirens.

For this reason, the detection power of the device was evaluated by simulation experiments. First, three conditions of background traffic noise were selected as representative. They are: (*a*) constant speed driving at 50 km h^{-1} in a downtown area in fine weather conditions (background noise level $N = 86$ dB), (*b*) the same driving under a moderate to strong rain ($N = 91$ dB), (*c*) starting at a road crossing with surrounding cars when the traffic signal changes from red to green ($N = 92$ dB). The actual background noise was recorded by a microphone attached to the rear window of a small passenger car. Secondly, as the sources of traffic-alarm sounds, a total of 140 alarm sounds were collected. They are (i) horns of 18 motorcycles, 4 small cars (cylinder capacity less than 0.55 l), 63 passenger cars and small to mid size trucks which include 9 cars made in the USA and West Germany, 33 large buses and trucks; (ii) the sirens of 16 emergency vehicles which include ambulances, police motorcycles, police cars and fire engines; (iii) the alarm signals of 6 railway crossings. The alarm sounds were recorded by an omnidirectional microphone at a distance of 10 m from the front edge of the sound source. The alarm sounds then recorded were electrically mixed with the prerecorded background traffic noise, and the minimum SPL of the alarm sound that could be detected by the device was measured. Finally, this SPL was converted to the maximum car-to-sound source distance under the assumption that the SPL is inversely proportional to the distance. This assumption holds true for a point sound source in a unbounded acoustic space, and it was confirmed by a preliminary experiment that the assumption approximates the actual car-road condition with an error of about 30%. Although the present device employs an omnidirectional microphone, attachment of the microphone to the car and the rain hood generate directionality. Here, it is assumed that the alarm sound comes into the car from behind. In this case, the effective sensitivity of the microphone increases by 4 dB.

Table 1 shows the distribution of the maximum distance thus calculated for each category of alarm sound. For example, in the case of constant speed drive at 50 km h^{-1} under fine weather conditions (*a*), out of 18 horns of motorcycles, 4 horns are detectable up to 5–10 m, 11 horns are detectable up to 10–20 m, and 3 horns are detectable up to 20–30 m. In all conditions, sirens are very easy to detect. This is because the SPL of a siren is high and the spectrum structure of a siren is simple so the line spectrum detectors can detect the presence of the line spectrum very easily. Horns are detectable at longer distances in the order: horns of large buses and trucks, then passenger cars, small cars and, finally, motorcycles. The reasons why the alarm signal of railway crossings are difficult to detect are that the SPL of the alarm signal itself is low and that the spectrum structure of the alarm signal is complex. In rough summary, the detection power of the device compares with that of a hearing driver who drives in a car with all windows closed.

The above result is obtained under the assumption that the alarm sound comes into the car from behind. If it comes into the car from a right angle or from the front, the maximum distance for correct detection decreases to about one-half and one-third, respectively, because of the directionality due to the arrangement of the microphone.

3.3 *Road tests*

To assess the detection power of the device and the frequency of false alarms in actual driving, road tests were made with a compact-size passenger car under the following conditions: (i) 30 minutes drive in moderately crowded downtown roads in Tokyo (the distance travelled = 10 km, fine weather), (ii) 32 minutes drive on the same roads in relatively strong rain, (iii) 46 minutes drive in very crowded downtown roads in Tokyo (11 km, fine weather), (iv)

Table 1 Distribution of the maximum distance for signal detection

(*a*) distance, m	0–1	1–5	5–10	10–20	20–30	30–50	50–100	100–200	200–	Total
motorcycle			4	11	3					18
small car				3		1				4
passenger car, small truck				9	18	27	9			63
large bus, truck				1		5	27			33
siren								1	15	16
railroad crossing		4	2							6

(*b*) distance, m	0–1	1–5	5–10	10–20	20–30	30–50	50–100	100–200	200–	Total
motorcycle			13	5						18
small car			1	3						4
passenger car, small truck				17	33	13				63
large bus, truck				1	2	8	22			33
siren								1	15	16
railroad crossing		5	1							6

(*c*) distance, m	0–1	1–5	5–10	10–20	20–30	30–50	50–100	100–200	200–	Total
motorcycle		1	6	10	1					18
small car			2	2						4
passenger car, small truck				22	29	9	3			63
large bus, truck				1	6	18	8			33
siren								1	15	16
railway crossing	1	4	1							6

(*a*) fine weather, 50 km/h ($N = 86$ dB)
(*b*) rain, 50 km/h ($N = 91$ dB)
(*c*) fine weather, starting ($N = 92$ dB)

minutes drive in rural roads (10 km, fine weather), (v) 23 minutes drive on an unpaved forestry road (7 km, fine weather), (vi) 64 minutes drive on an express highway (98 km, fine weather).

In all conditions, the device detected all the large horns which could be detected by the hearing driver quite clearly. 70 per cent of the middle horns which could be detected by the hearing driver with moderate ease were detected by the device. 50 per cent of the small horns which could be detected by the hearing driver with some care were detected by the device. The device detected several very small horns which the hearing driver did not catch.

The frequency of false-alarm was 10, 11, 20, 9, 0 and 8 times in conditions (i) to (vi), respectively.

3.3 *Response time*

If the time (T_d) between the onset of the alarm sound and the action of the aurally-handicapped driver in response to the light of the LED is considerably longer than the response time of the hearing driver (T_h), the use of the device involves a safety problem. To compare T_d with T_h the following experiment was made. Background traffic noise of 6 min duration was recorded in an actual downtown drive in Tokyo. Sixteen alarm sounds of prerecorded horns were mixed with this background noise in middle volume at random time intervals. These horns are the horns of 3 motorcycles, 8 passenger cars, and 5 buses and trucks. The test tape thus created was replayed and the sound was fed to the device. Eleven subjects with severe hearing loss were asked to press a lever of a micro-switch with their first finger as quickly as possible when the LED was lit by the device. The same test tape was replayed and the sound was heard by 11 hearing subjects. They were also asked to press the lever as quickly as possible when they detected the horn amongst the background noise. For each subject, the mean of T_d or T_h over 16 horns were calculated and designated as $\bar{T}_d$ and $\bar{T}_h$, respectively. The mean and standard deviations of $\bar{T}_h$ over 11 hearing handicapped subjects were 344 ms and 45 ms. The mean and standard deviations of $\bar{T}_h$ over 11 hearing subjects were 274 ms and 35 ms, respectively. For information, the mean and standard deviation over 16 horns of the delay time between the onset of the horn and the onset of the LED light were 56 ms and 27 ms.

4 Discussion

The results of simulation experiments and road tests demonstrate the basic effectiveness of traffic-alarm sound detection based on the line spectrum detection algorithm. However, as shown in Table 1, the power of the device to detect alarm signals of railroad crossings is very poor, and the device is practically useless for this purpose. Fortunately, railway crossings are equipped with flashing lights and lifting gates, and thus this problem is not very serious for safe driving. As for sirens, very high detection power was achieved for all 16 sirens tested. This is a marked improvement over the device developed by the Ministry of Welfare of Japan. In particular, when considering the fact that aurally-handicapped drivers take care in driving so that they do not provoke the drivers of surrounding cars to blow their horns, this improvement is very significant. Further, even in many countries where the driver's licence is qualification-free, there is a demand for a device that can at least detect the siren. In such a case, the device can be greatly simplified by eliminating channels 0, 1A, 1B, 6, 7 and the error suppress circuit. The circuit constants of the mid frequency channels can be optimised to further reduce the chance of false-alarm (see MIYAZAKI and ISHIDA, 1984, for details).

As for the power of the device to detect horns, satisfactory power was achieved in the case where the alarm sound comes into the car from behind. The detection power decreases when the alarm sound comes into the car from a right angle or from the front because of the directionality of the microphone due to its arrangement with respect to the rain hood. However, the decrease in detection power can be partially compensated for by vision, and this will not be a major practical problem. Of course, it would be desirable if a completely omnidirectional microphone could be realised. However, taking into consideration the fact that there is no small waterproof microphone and that the wind noise increases considerably if the microphone is placed on the roof of the car, there is no easy solution to this problem at present.

The response time of the aurally-handicapped subjects using the device ($\bar{T}_d$) is slightly longer than the response time of the hearing subjects ($\bar{T}_h$). This result, however, was obtained under the condition that the subjects maintained their mental stress at a very high level during the 6 min experimental session and reaction involved a fine movement of the first finger. In actual driving, the mental stress is at a much lower level and the reaction is in the form of gross movements of the foot, leg and arm. Thus, it is expected that there will be no significant difference between the response time of aurally-handicapped drivers and that of hearing drivers.

This device was originally designed and developed for the hearing handicapped people of Japan who are not eligible for a driver's licence. Technically speaking, however, the device should be able to be used as effectively in other countries as in Japan. Nine electric horns of passenger cars made in the USA and Germany tested in Section 3.2 showed basically similar spectral structure to the horns of the remaining 66 passenger cars made in Japan, in that one or two dominant line spectra exist in the high frequency range. Therefore, it is reasonable to assume that the horns of passenger cars of countries other than Japan can be detected as easily as those of Japanese cars. Some large trucks and buses may be equipped with a single air horn in other countries. In this case, a single dominant line spectrum appears in the low frequency range, and this spectrum can be very easily detected by channel 0, which is tuned to such a line spectrum. Thus, buses and trucks are no problem in other countries. Lastly, it is true that tones of sirens of emergency vehicles in other countries are slightly different from those of Japanese ones. However, the sounds of 26 sirens made in the USA, the UK, and Germany collected at the time of revision of the manuscript showed one or two strong line spectra in the mid frequency range without exception. Therefore, these sirens should be quite easily detected by the device, as is the case with Japanese sirens.

Apart from the technical points, it is not clear at this moment whether the device is needed in other countries as much as in Japan. A preliminary review of the situation in 32 countries revealed that Japan, Sweden and Hong Kong are the three exceptional countries where there is strict regulation on a car driver's licence. In other countries where the licence is qualification-free, there may be less motivation for aurally-handicapped drivers to buy and use such a device.

The major practical problems of the device are: (*a*) it generates false alarms, (*b*) it cannot display the information on the loudness of, and thus the distance to, the alarm sound, and (*c*) it cannot give information on the direction of the alarm source. There is no immediate answer as to

the effect of these problems on the safety of driving and the mental fatigue of the driver. Long-term road tests are now being conducted with 5 volunteers who have severe hearing loss and who barely passed the hearing test for a driver's licence in Japan. The results of these road tests will be reported in a separate paper.

Acknowledgments—The authors would like to express their thanks to Mr. H. Shono of Rion Co. Ltd., and Mr. K. Sugawara who kindly provided the circuit diagram of the device developed by the Ministry of Welfare of Japan. They would like to thank many Japanese car manufacturing companies and dealers, and Yanase Co. Ltd. for offering the opportunity to record the raw sound of various alarm sounds. They would also like to thank the head teacher, Mr. T. Kai, teacher, Mr. T. Higashi, and the students of Tokyo Shakujii Deaf High School for co-operation in the response time experiment. Several helpful suggestions in the early stages of the design of the electronic circuit by Dr. M. Takahashi of the Institute of Medical and Dental Engineering are gratefully acknowledged.

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Authors' biographies

Shinji Miyazaki was born in Shizuoka, Japa in 1949. He received the B.E., M.Sc., an Ph.D. degrees in Electrical Engineering fro the University of Tokyo, Japan, in 1971, 19 and 1979. Since 1973 he has been working as research instructor at the Institute for Medic & Dental Engineering, Tokyo. In 1979 a 1980 he was an exchange graduate student Moss Rehabilitation Engineering Center, Ph adelphia, USA. His research interests lie in the area of rehabi tation engineering in general.

Akimasa Ishida was born in Korea in 19 He received the Ph.D. degree in Contr Engineering from Tokyo Institute of Tec nology, Japan, in 1969. He has worked at t Tokyo Institute of Technology, and the Ins tute for Medical & Dental Engineeri Tokyo. He was a visiting scientist at t National Research Council of Canada in 19 and 1984 and is currently a professor at Institute for Medical & Dental Engineering, Tokyo. His resea activities include the analysis of the motor control systems a posture control systems, the measurement and evaluation of sc iosis, and the measurement of three-dimensional movement of gleno-humeral joint.

Appendix W: British Columbia Otolaryngological Society Resolution of June 5, 1998 (Amendment to the Resolution of April 4, 1997)

After reviewing the existing literature, a Subcommittee of the British Columbia Otolaryngological Society recommends that the decibel degree of hearing loss of an individual should not preclude the individual from obtaining a class 1 drivers licence (excluding passenger carrying vehicles and emergency vehicles). The Subcommittee concludes that this is an issue of communication, and not a medical or health issue. Consideration of the individual for a class 1 drivers licence should therefore be based on factors excluding degree of hearing loss. No decibel restriction should apply. As well, proven and available technology should be employed for such drivers[35].

[35] Note: The BCOS or the BCMA has not approved the above resolution. The Resolution does not address the issue of dangerous goods or the issue of uncontrolled railway crossings.

Appendix X: Estimated Cost of Committee

The cost of the Committee and resulting report is estimated to be approximately $50, 000, encompassing such costs as: salaries, travel costs, contractors fees, preparation time, interpreter services and Per Deum charges. The Office of the Superintendent of Motor Vehicles paid all expenses.